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Berkeley, California

Western Mining in the Twentieth Century
Oral History Series

Arthur I. Johnson

MINING AND METALLURGICAL ENGINEER IN THE BLACK HILLS:

PEGMATITES AND RARE MINERALS, 1922 TO THE 1990s

With an Introduction by
Maurice Fuerstenau

Interviews Conducted by
Eleanor Swent
in 1989

Since 1954 the Regional Oral History Office has been interviewing leading participants in or well-placed witnesses to major events in the development of Northern California, the West, and the Nation. Oral history is a modern research technique involving an interviewee and an informed interviewer in spontaneous conversation. The taped record is transcribed, lightly edited for continuity and clarity, and reviewed by the interviewee. The resulting manuscript is typed in final form, indexed, bound with photographs and illustrative materials, and placed in The Bancroft Library at the University of California, Berkeley, and other research collections for scholarly use. Because it is primary material, oral history is not intended to present the final, verified, or complete narrative of events. It is a spoken account, offered by the interviewee in response to questioning, and as such it is reflective, partisan, deeply involved, and irreplaceable.

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It is recommended that this oral history be cited as follows:

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ARTHUR I. JOHNSON
1989

Cataloging Information

Arthur I. Johnson (b. 1889) Mining, Metallurgical Engineer

Mining and Metallurgical Engineer in the Black Hills: Pegmatites and Rare Minerals, 1922 to the 1990s.
1990, xiii, 114pp.

Childhood in Lead, South Dakota; working in gold mine and mill; education, South Dakota School of Mines; engineer for development, design, construction, and operation of Black Hills mines and mills to produce arsenic, bentonite, beryl, feldspar, gold, lepidolite, lithium, mica, silver, spodumene, tantalum, tin, tungsten; surveyor, initial road-builder for Mt. Rushmore National monument site.

Appendix includes selected writings on history of Black Hills mining.

Introduction by Maurice Fuerstenau, Echo Bay Distinguished Professor, Mackay School of Mines, University of Nevada-Reno.

Interviewed in 1989 by Eleanor Swent for Western Mining in the Twentieth Century series. The Regional Oral History Office, The Bancroft Library, University of California, Berkeley.

The Regional Oral History Office in behalf
of future researchers, wishes to thank
the following donors whose contributions made possible
this oral history of Arthur I. Johnson.

Special thanks to Professor Maurice Fuerstenau for his leadership.

The Black Hills Section of the American Institute of Mining,
Metallurgical, and Petroleum Engineers

Homestake Mining Company

South Dakota School of Mines and Technology

Wharf Resources, Limited

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PREFACE

The oral history series on Western Mining in the Twentieth Century documents the lives of leaders in mining, metallurgy, geology, education in the earth and materials sciences, mining law, and the pertinent government bodies. The field includes metal, non-metal, and industrial minerals, but not petroleum.

Mining has changed greatly in this century: in the technology and technical education; in the organization of corporations; in the perception of the national strategic importance of minerals; in the labor movement; and in consideration of health and environmental effects of mining.

The idea of an oral history series to document these developments in twentieth century mining had been on the drawing board of the Regional Oral History Office for more than twenty years. The project finally got underway on January 25, 1986, when Mrs. Willa Baum, Mr. and Mrs. Philip Bradley, Professor and Mrs. Douglas Fuerstenau, Mr. and Mrs. Clifford Heimbucher, Mrs. Donald McLaughlin, and Mr. and Mrs. Langan Swent met at the Swent home to plan the project, and Professor Fuerstenau agreed to serve as Principal Investigator.

An advisory committee was selected which included representatives from the materials science and mineral engineering faculty and a professor of history of science at the University of California at Berkeley; a professor emeritus of history from the California Institute of Technology; and executives of mining companies.

We note with much regret the death of two members of the original advisory committee, both of whom were very much interested in the project. Rodman Paul, Professor Emeritus of History, California Institute of Technology, sent a hand-written note of encouragement just a few weeks before his death from cancer. Charles Meyer, Professor Emeritus of Geology, University of California at Berkeley, was not only an advisor but was also on the list of people to be interviewed, because of the significance of his recognition of the importance of plate tectonics in the genesis of copper deposits. His death in 1987 ended both roles.

Thanks are due to other members of the advisory committee who have helped in selecting interviewees, suggesting research topics, and raising funds.

Unfortunately, by the time the project was organized several of the original list of interviewees were no longer available and others were in failing health; therefore, arrangements for interviews were begun even without established funding.

The project was presented to the San Francisco section of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME) on "Old-timers Night," March 10, 1986, when Philip Read Bradley, Jr. was the speaker. This section and the Southern California section provided initial funding and organizational sponsorship.

The Northern and Southern California sections of the Woman's Auxiliary to the AIME (WAAIME), the California Mining Association, and the Mining and Metallurgical Society of America (MMSA) were early supporters. Several alumni of the University of California College of Engineering donated in response to a letter from Professor James Evans, the chairman of the Department of Materials Science and Mineral Engineering. Other individual and corporate donors are listed in the volumes. The project is ongoing, and funds continue to be sought.

Some members of the AIME, WAAIME, and MMSA have been particularly helpful: Ray Beebe, Katherine Bradley, Henry Colen, Ward Downey, David Huggins, John Kiely, Noel Kirshenbaum, and Cole McFarland.

The first five interviewees were all born in 1904 or earlier. Horace Albright, mining lawyer and president of United States Potash Company, was ninety-six years old when interviewed. Although brief, this interview will add another dimension to the many publications about a man known primarily as a conservationist.

James Boyd was director of the industry division of the military government of Germany after World War II, director of the U.S. Bureau of Mines, dean of the Colorado School of Mines, vice president of Kennecott Copper Corporation, president of Copper Range, and executive director of the National Commission on Materials Policy. He had reviewed the transcript of his lengthy oral history just before his death in November, 1987.

Philip Bradley, Jr., mining engineer, was a member of the California Mining Board for thirty-two years, most of them as chairman. He also founded the parent organization of the California Mining Association, as well as the Western Governors Mining Advisory Council. His uncle, Frederick Worthen Bradley, who figures in the oral history, was in the first group inducted into the National Mining Hall of Fame, Leadville, Colorado, in 1988.

Frank McQuiston, metallurgist, vice president of Newmont Mining Corporation, died before his oral history was complete; thirteen hours of taped interviews with him were supplemented by three hours with his friend and associate, Robert Shoemaker.

Gordon Oakeshott, geologist, was president of the National Association of Geology Teachers and chief of the California Division of Mines and Geology.

These oral histories establish the framework for the series; subsequent oral histories amplify the basic themes.

Future researchers will turn to these oral histories to learn how decisions were made which led to changes in mining engineering education, corporate structures, and technology, as well as public policy regarding minerals. In addition, the interviews stimulate the deposit, by interviewees and others, of a number of documents, photographs, memoirs, and other materials related to twentieth century mining in the West. This collection is
being added to The Bancroft Library's extensive holdings.

The Regional Oral History Office is under the direction of Willa Baum, division head, and under the administrative direction of James D. Hart, director of The Bancroft Library.

Interviews were conducted by Malca Chall and Eleanor Swent.

Willa K. Baum, Division Head
Regional Oral History Office

Eleanor Swent, Project Director
Western Mining in the Twentieth
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Western Mining in the Twentieth Century Oral History Series
Interviews Completed or in Process, August 1990

Horace Albright, Mining Lawyer and Executive, U.S. Potash Company, U.S. Borax, 1933-1962, 1989

James Boyd, Minerals and Critical Materials Management: Military and Government Administrator and Mining Executive, 1941-1987, 1988

Philip Read Bradley, Jr., A Mining Engineer in Alaska, Canada, the Western United States, Latin America, and Southeast Asia, 1988

Catherine C. Campbell, Ian and Catherine Campbell, Geologists: Teaching, Government Service, Editing, 1989

Helen R. Henshaw, Recollections of Life with Paul Henshaw: Latin America, Homestake Mining Company, 1988

Lewis L. Huelsdonk, Manager of Gold and Chrome Mines, Spokesman for Gold Mining, 1935-1974, 1988

Arthur I. Johnson, Mining and Metallurgical Engineer in the Black Hills: Pegmatites and Rare Minerals, 1922 to the 1990s, 1990

Evan Just, Geologist: Engineering and Mining Journal, Marshall Plan, Cyprus Mines Corporation, and Stanford University, 1922-1980, 1989

Malozemoff, Plato, A Life in Mining: Siberia to Chairman of Newmont Mining Corporation, 1909-1985, 1990

Frank Woods McQuiston, Jr., Metallurgist for Newmont Mining Corporation and U.S. Atomic Energy Commission, 1934-1982, 1989

Gordon B. Oakeshott, The California Division of Mines and Geology, 1948-1974, 1988

Samuel S. Arentz, Jr. (Escalante Mine), in process
James T. Curry, Sr. (Newmont, Calaveras Cement Company), in process
Donald Dickey (Oriental Mine), in process
James M. Gerstley (U.S. Borax), in process
George Heikes (tungsten, zinc), in process
Vincent Perry (Anaconda), in process
Carl Randolph (U.S. Borax), in process
Langan Swent (San Luis, Homestake, uranium mining), in process
Alexander Wilson (BHP-Utah), in process

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California Institute of Technology

Mr. Langan W. Swent
Vice President (retired), Homestake Mining Company

* Deceased during the period of the project

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INTRODUCTION by Maurice C. Fuerstenau

It has been my pleasure to know Arthur I. Johnson for the last twenty years, principally through our association with the American Institute of Mining Engineers [AIME]. Mr. Johnson, a Legion of Honor Member of AIME, has had a lengthy and rewarding career in the mineral industry, most notably in the Black Hills. In fact, one is hard pressed to think of a person who has had greater involvement with mining and metallurgy in this region. His impact has been great!

A.I., as he is called, was born in 1899 and his involvement with the mineral industry encompasses seventy-eight years. The history of his family in mining goes back considerably further than that, though. The first ancestor of whom his family has any history is Arendt Grape, who went from Germany to Sweden in the 1600s to open an iron mine.

In 1903 A.I.'s father was killed in an accident at the Homestake Mine. This unfortunate incident had a tremendous impact on his life. It was necessary for him to work summers at an early age and part time in high school to help support the family. As a result he developed a strong work ethic which has continued throughout his life. During his summer work experiences with Homestake, he decided that if he could ever go to college, he would major in mining and metallurgy.

Fortunately for the industry, he was able to go to the South Dakota School of Mines began. He was drafted into the army in 1919, about the time World War I was ending. Since the army had a bomb section, they sent him to study at the School of Mines. He obtained a degree in metallurgical engineering in 1922 and a degree in mining engineering in 1926.

A.I.'s career as a metallurgist spanned the next sixty-eight years. His career has involved developing processes, designing plants and supervising their construction in the processing of numerous valuable minerals, namely, arsenic, gold, silver, lead, zinc, tantalum, tin, feldspar, mica, beryl, spodumene, and uranium.

His first industrial experience as a metallurgist was to develop a process and build a plant to process a gold-bearing ore containing arsenopyrite. In addition to the gold values, the ore was also processed for white arsenic. Safety precautions being what they were back then, A.I. was hospitalized for three weeks due to arsenic poisoning.

Next, he turned his attention to gold ore processing at the Bullion Mine. The significant aspect of this work was his introduction of countercurrent decantation into the flowsheet. This technology was first used in Canada. Upon hearing of it, A.I. contacted the superintendent at

that operation for details and then put in a circuit at the Bullion Mine. For certain, it was the first of its kind in the Black Hills and probably in the United States. This technology is still employed in the precious metals industry today.

When the names of most of the mines in the Black Hills are discussed, namely, the Homestake, Bald Mountain, Bullion, Etta, Hugo, Peerless, Ingersoll, Sitting Bull, Golden Slipper, Frerichs, Tinton, Holy Terror, Belle Eldridge, Columbia, Juniper and Empire, it comes to mind that these are all mines at which A.I. Johnson either worked or, in many cases, developed processes and built or modified mills for ore processing. Many of the mines contained pegmatite minerals (mica, beryl, feldspar and spodumene) for which the Black Hills are famous. A.I. ranks as one of the pioneers in the development of processes and plants to concentrate these minerals.

In the 1950s, like many others, A.I. became involved with the uranium industry. He spent considerable time in the Edgemont, South Dakota area as well as the Ambrosia Lake District in New Mexico and around Riverton, Wyoming conducting geological studies and mine valuation.

When one's life spans a century, especially the twentieth century, one has seen fantastic changes, especially in technology. For example, the froth flotation process, one of the most technologically-significant developments of the twentieth century and one of the processes used by A.I. to concentrate pegmatite minerals, was discovered and perfected in this time frame. A person also has had the opportunity to become involved with projects and associations in their industry. For President Coolidge's dedication of Mt. Rushmore, A.I. was asked to survey the road to the plateau designated for the dedication. He also surveyed the lines for bringing in electric power from Keystone to Mt. Rushmore and to the State Game Lodge. The latter earned him the wrath of Doane Robinson, the state historian at that time, for defacing nature.

It is certainly fitting that we have an oral history from A.I. Johnson and that this presentation be made at a Black Hills Section Meeting of AIME as A.I. has been an AIME member for seventy years. The legacy of mining in the Black Hills is rich and varied. Much of this is captured in the narration of the experiences encountered in this grand old gentleman's professional career.

Maurice C. Fuerstenau
Echo Bay Mines Distinguished Professor

July 1990
Department of Mining Engineering
Mackay School of Mines
University of Nevada, Reno

INTERVIEW HISTORY

Arthur I. Johnson was selected for the series on Western Mining in the Twentieth Century because of his role in the mining of pegmatites and rare minerals in the Black Hills of South Dakota. Mr. Johnson, senior mining engineer in the Black Hills, has been honored as a fifty-year member of the American Institute of Mining, Metallurgical, and Petroleum Engineers; he is also one of the oldest alumni of South Dakota School of Mines and Technology [SDSMT]. His oral history tells of his long career as an engineer and entrepreneur.

Black Hills pegmatites have been mined since 1879; feldspar and mica mines abound in the region. The Etta mine, one of many mentioned in Mr. Johnson's oral history, is noted for producing spodumene crystals averaging ten feet in length, with some as long as forty feet. Arthur I. Johnson has been involved in developing, converting, or reviving pegmatite mines in response to demand for minerals such as beryl, lepidolite, lithium, mica, tantalum, and tin. In addition, he designed and built one of the first mills in the United States using a countercurrent decantation system.

Mr. Johnson traces his ancestry back several hundred years to a mining engineer in the Kiruna district of northern Sweden. Arthur Johnson's father, who immigrated from Sweden to the Black Hills in the late nineteenth century, was killed in an accident at the Homestake Mine in 1903. Arthur's story proceeds in the classic mold: putting himself through school by getting up in the middle of the night to stoke boilers at school and church; working ten hours a day as a railroad section hand at the age of thirteen; beginning his metallurgical career as a boy of fourteen, cleaning amalgam plates at a mill. In 1911, he joined one of the first Boy Scout troops in America. As a high school student, he learned fire assaying by working nights and weekends with one of his teachers.

He served in the army during World War I, then worked his way through the South Dakota School of Mines, graduating in 1922. Continuing to work and study for his master's degree, he developed a roasting method

to extract gold from the blue ores of Trojan, raising the recovery from 60 percent to 93 percent. For his mining engineering degree, granted in 1926, he studied the Keystone District, which has been his home ever since.

His career exemplifies the cyclical nature of the minerals industry. He designed, built, and operated mines and mills to produce minerals which were in demand at the time: arsenic to kill the cotton boll weevil, beryl for use in medicine and in the development of atomic fission, lepidolite for making unbreakable glass for airplane windows. He mined lithium when it was sought by the War Production Board, and he mined the first bentonite produced in the region. Few of these ventures ended because the ore ran out; usually there was an economic or political reason. In three cases, mills were destroyed by fire. He dewatered a mine which had flooded; he successfully located an aquifer for a mine which lacked water. Twice he was able to locate "lost" faulted veins of ore and so to prolong the life of a mine.

As the only trained engineer in the area, he was hired to survey for the power line and build the first road to the site of Mt. Rushmore National Monument, and provided equipment to haul President Coolidge's car for the dedication ceremony.

He served two terms as South Dakota State Mine Inspector, overseeing the safety of mines ranging from the huge Homestake to small pits and quarries.

From the beginning of the oral history series on Western Mining in the Twentieth Century, Professor Douglas Fuerstenau, principal investigator for the series, recommended including the documentation of this career. His brother, Professor Maurice Fuerstenau, then at SDSMT and now at Mackay School of Mines, University of Nevada-Reno, took the initiative in raising necessary funds.

I first met with Mr. Johnson for a planning session at his home in Keystone, South Dakota, on 17 August 1989. Two interview sessions followed: the first at his home on 21 August and the second on 24 August in Lead, South Dakota. His wife Willmeta was present for part of both interviews, but did not participate except when asked for corroboration.

Their hillside home is picturesque, and a lesson in geology. The garage is built of local stone; the walkway and garden terraces are made of the sparkling metamorphic schist characteristic of the region. Scattered among the flower beds are beautiful specimens of rose quartz. Slate steps lead into the house, where a stone fireplace wall dominates the living room. There are many photographs of children and

grandchildren, as well as one of the Senator from South Dakota. A tape recorder and record player are beside Mr. Johnson's armchair to assist him in reading.

Mr. Johnson's mental faculties are remarkably acute, but his eyesight has failed; therefore, his wife's help in reviewing the manuscript was invaluable. Very few corrections were made, and the transcript was promptly returned. The appendix includes materials from Mr. Johnson's speeches and writings on the history of mining in the Black Hills. The tapes of the interviews are deposited at The Bancroft Library, University of California at Berkeley.

Eleanor Swent, Project Director
Western Mining in the Twentieth
Century Series

11 June 1990
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PROFESSIONAL HISTORY

ARTHUR I. JOHNSON

Consulting Mining Engineer

Professional Engineer

Keystone, S. D.

1922-Graduate South Dakota School of Mines. BS Metallurgical Engineering.
1923-Graduate study, SDSM, for advanced degree Metallurgical Engineer.
1923-25- Instructor at SDSM.
1926-Engineer of Mines degree, SDSM.
1926-27- Taught at Texas A&M College, Civil Engineering.
Designed and operated a White Arsenic Plant for Keystone Arsenic Co., and a Milling Plant for recovery of arsenical concentrates.
Testing Engineer for International Smelting Co. at Inspiration, AZ, to devise a new method for feeding reverberatory furnaces.
1928-30-Designed and developed flowsheet for 100-ton Counter Current Cyanide Plant for the Keystone Gold Mining Co.and operated same at Keystone. Plant burned down in January, 1930.
1930-32-Development of underground gold ore reserves for Keystone Gold Mining Co. and geological mapping.
1933-34-Developed the Ingersoll Mine for Black Hills Keystone Corp. for beryl and lepidolite. Developed process for recovery of lepidolite from low grade ores.
1934-35-Developed and renovated the Golden Slipper Mine for Empire Gold Mines. Designed and built mill for processing the gold ore.
1935-36-Designed and operated a Counter Current Cyanide Plant for the Frerichs Gold Mining Co. at Deadwood in conjunction with Prof. Bancroft Gore, professor of metallurgy at SDSM.
1936-38-Investigated tantalite possibilities in the Black Hills, Wyoming and Colorado for Fansteel Metallurgical Corp. of North Chicago. Supervised setting up a plant for concentrating ore for this company at Tinton and supervised same for production of tantalite concentrates.
1939-40-Test work for Black Hills Tin Co. to develop a process for flotation of lithium ore, spodumene. Converted a tin-mica processing plant a t Tinton to produce spodumene flotation concentrates. This was the first plant of its kind anywhere and became the basis for other plants in the Black Hills and also at Kings Mountain, NC.
1940-42-Took over the gold milling operations and mining operations of the Holy Terror Mining Co. at the Keystone Mine. Operated same until September of 1942 when by government decree all gold operations in the U.S. were closed to transfer personnel to base metal production for the war effort.
1942-45-Built and designed a spodumene flotation plant for the Black Hills Tin Co. with RFC funds. Operated this to the end of World War II.
1944-45-Supervised mica operations for Mineral Mills Inc. at Custer, building three rifting and sheeting plants for production of sheet mica for Colonial Mica Corp., the government agency. The three plants were in operation at Custer, Hill City and Deadwood.
1946-48-Designed, constructed and operated a mica milling facility for Mineral Mills at the Old Mike Mine near Custer to recover scrap mica from pegmatite ores.
Consulting work for the Belle Eldridge Gold Mining Co. at Deadwood, processing zinc ores. Modified flotation plant for production of larger tonnages of ore for larger shipments of concentrates. This

work continued to 1952. Supervised geological work, diamond drilling and exploration for further tonnages.

1948-49-Built a flotation plant for lepidolite, a lithium ore, at the Ingersoll Mine for Black Hills Keystone Corp. Operated same.

1950-52-Designed and built a milling plant for Southern Mines, Inc., to process gold ores from the Juniper Mine near Keystone. Developed reserves.

1953-55-Remodeled the gold plant of the Holy Terro Mining Co. into a spodumene flotation plant and operated it for Uranium and Allied Minerals Inc. , shipping concentrated to Lithium Corp of America.

1956-60-Designed and developed a beryllium processing plant for Key Chemical Co. at Keystone for conversion of beryl to beryllium flouride for shipment to the government facility.

1960-64-Designed and supervised building of a flotation plant for Northwest Beryllium Corp. at Keystone to process pegmatite ores for recovery of mica, feldspar, beryl and tantalite-columbite. This was a complex four mineral separation by flotation of non-metallic ores.
Made uranium explorations.

1965-70-Consulting work on processing ores, design of recovery plants, geological mapping of deposits for reserves,etc.
Principal program for a New York group in separation of clean quartz by electro-static processing. Investigation of the conversion of feldspar into alumina and potash residues for agriculture use.
Served as State Mine Inspector under Governors Boe and Farrar.

1970-80-Continued consulting work for companies previously listed.
Gave papers at internation meetings of the American Institute of Mining and Metallurgical Engineers in San Francisco and in Orlando, FL, on flotation process for lepidolite and on pegmatites of the Black Hills.

1980-85- Consulting work.
Investigation of tin, copper and silver deposits of the Black Hills.

Registered Professional Engineer since 1935
Honorary Life Member of Professional Engineering Society of South Dakota
Honorary Life Member of A.I.M.E.

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BIOGRAPHICAL INFORMATION

(Please write clearly. Use black ink.)

Your full name Arthur L. Johnson

Date of birth Feb. 20, 1899 Birthplace Lead, South Dakota

Father's full name Isaac Wilhelm Johnson

Occupation Miner Birthplace Baherta, Sweden

Mother's full name Hilda Katerina Grape Johnson

Occupation Homemaker Birthplace Overtornea, Sweden

Your spouse Willmeta Schafer Johnson

Your children Carolyn Willmeta Odegard
Susan Gay Prahl

Where did you grow up? Lead, SD

Present community Keystone, SD

Education Lead High School, SD School of Mines & Technology,
Chicago University, Texas A & M.

Occupation(s) Consulting Mining & Metallurgical Engineer
Professional Engineer

Areas of expertise Research, design and construction milling plants, mine development in gold and pegmatite minerals, geological studies.

Other interests or activities Community, school, church, lodge, mining history research.

Organizations in which you are active Congregational, UCC Church, Masonic Bodies, Keystone Historical Society, Rotary Club, Darton Society, AIME, SD Engineering Society.

I FAMILY AND EDUCATION

[Interview 1: August 21, 1989]##[1]

Growing Up in Lead, South Dakota

Swent: Mr. Johnson, most mining people get into the work because of a family connection, but yours goes back a lot longer than most, I think.

Johnson: You might say it got back full circle, because my folks--both my mother and my father--came from Sweden, and that was in the late nineties. My father was killed in a mine accident at the Homestake Mine way back in 1903.

Swent: And you were born in--?

Johnson: In 1899, so I was only a very young boy at the time my father was killed. I had a brother and a sister both, and my mother was left without any means of support, more or less, you might say.

Swent: Did the companies give the widow anything in those days?

Johnson: As I remember, there wasn't any mention of a compensation. In those days, I believe they hadn't even got to that kind of a consideration. Well, as a result of all this, I had to go to work as soon as I could. I remember my first job was on the section crew in 1912. I was going to grade school at the time and working during the summer. We got the exact sum of fifteen cents an hour for a ten-hour day.

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[1]This symbol (##) indicates that a tape or a segment of a tape has begun or ended. For a guide to the tapes see page 67.

Swent: Was this for Homestake?

Johnson: No, this was Northwestern Railroad on a section crew. As a part of this work, we on the section crew were compelled to build our railroad up every time, because the railroad went right over an old stope near the Amicus Mill. Our first job every day was to raise the track back to normal, and it was while I was working there--this morning in particular, because President Taft was coming for a meeting in Lead, and we had to be sure the track was level.

During the wait, I went across to the Amicus Mill, which was only probably a hundred feet away, and got my first glimpse of a mill of that type. I talked to the foreman. I said, "Well, how could I get a job here?" because I was interested in getting a job that would pay a little more money. He said, "Well, you go talk to the old man." He referred to the employment agent. They called him the old man. I decided I would do that right then, so within a day or so, I went there, and I was employed within a couple of days. I went to work in the Amicus Mill there as a plate boy. We had to strip the amalgam off the plates, and we had to put a new coating of mercury on. This was a thousand-ton mill. There were two of us working there, and we had to do the job every single day, ten hours a day, so I got quite well versed in the work in a mill of that nature.

Swent: Was this only during vacations?

Johnson: This was only during vacations.

Swent: How much were you paid? Do you remember?

Johnson: Yes. I got an increase of ten cents an hour to twenty-five cents an hour. We really got paid. [chuckles]

Swent: When was this?

Johnson: In 1912.

Swent: That's right. That's when Taft came.

Johnson: Yes. And so, every year after that, I had a job every summer with Homestake. I worked in their pattern shop, and the machine shop. I finally got a job down in Deadwood in their slime plant, which was a cyanide slime plant. That added to my background for the kind of work I wanted to do. That will bring back a lot of memories, of course, but it was during this period that I decided that if I ever could go to school, I would take up courses in

mining and metallurgy. It never appeared to be as though I could.

I was inducted into the army in the fall of 1918. I had an appointment to Annapolis and couldn't make it on account of a bad eye, and I enlisted in the army and was sent to Jefferson barracks. They turned me down for the same problem, so they finally told me when the draft came along I'd be taken anyhow. I was drafted in the spring of 1918, just a short while before the end of the war, because I was only in the army for about six months. I was sent to School of Mines in Rapid City, South Dakota. They had a mining section in the army then, which had to do with bombs et cetera, you know. When I was sent down there, I decided that if I ever had a chance, I would continue my education and when I was discharged there at the end of 1918, I enrolled at the School of Mines. That started me out in my education.

Attending the South Dakota School of Mines, 1918-1926

Swent: You were doing a work-study program before we had the term, weren't you?

Johnson: That's right. And then the only problem was how to continue, so I got work wherever I could. I had a job in the dining hall waiting tables and had a job, finally, as a man in charge of their bookstore. I worked in the various places while I was there.

Swent: And then in the summers you worked, too?

Johnson: In the summers, I went back to Lead and got a job with Homestake. I worked with Homestake underground, and I worked in the assay office. Different summers, you know, I had different jobs. I think I did everything in a mine from helpers to track men and drillers and any work that came up that was available at the time. So I got quite an experience there.

Swent: We mustn't forget to talk about your ancestor in mining.

Johnson: Oh, yes. Well, then, I might continue on the ancestor situation. The first ancestor that we have any history of is Arendt Grape, who came in from Germany and was sent there, to Sweden, to open up an iron mine. This was the ancestor that is shown on the genealogy as being the one that really got the family started in Sweden.

Swent: This was in the 1600s, you said.

Johnson: Yes. It was two hundred years later that I came there, so it must have been sixteen-hundred-something.

Swent: Three hundred years later.

Johnson: Three hundred years.

Swent: And he went to Kiruna, you said.

Johnson: Yes.

Swent: Northern Sweden.

Johnson: Northern Sweden and found out later, while we were there, that there was a street named after him. There was a statue of him, so they evidently remembered this ancestor from what he did there to get the mine started. While we were there, they told us they had ore for two hundred more years there, and there was a hundred-car train leaving for loading to ore containers and shipping the ore to various parts of the world, because it's a very unique ore in the sense that it was free of a lot of contaminants that have to be eliminated, to make a good iron product. That, in a sense, covers my ancestry. When my father came to the United States, he changed his name to Johnson, so that's how I happened to be named Johnson now instead of Grape.

Swent: That's very interesting. Probably some immigration official just decided that anybody from Sweden ought to be named Johnson.

Johnson: That could have been true. [laughter]

Swent: So when did you graduate, then, from the School of Mines?

Johnson: I graduated from the School of Mines in 1922, and took postgraduate work for a master's degree in '23, and graduated in June of '23 with a degree of Metallurgical Engineer. In 1926, I got the degree of Engineer of Mines, in order to round out my mining education. In my work for the master's degree, I took as a subject the "blue" ores of the Northern Black Hills.

Swent: Why are they called "blue?"

Johnson: Because they were blue--deep blue, almost black.

Swent: This was for gold?

Johnson: This was for gold.

Swent: What was so special about them?

Johnson: Well, in the method they were using to extract the gold, they could only get about 25, 30 percent extraction.

Swent: What were they using in those days? Just amalgamation?

Johnson: Well, they were using amalgamation, but this was during the period of cyanidation, though. After they had started cyaniding there, why, they still couldn't get their recoveries up until they ground it to three hundred or four hundred mesh. It wouldn't stand that kind of a cost, so two of us--George L. McCracken and I--decided we would take as a joint project the investigation of a probable ore extraction method. So we worked on that for the whole year for our master's degree. We worked out a recovery method that gave a recovery of over 90 percent.

Swent: Where were you doing this research? In the lab?

Johnson: In the labs there at the School of Mines. This method was a little different from ordinary roasting. We had to control the heat to keep it from getting too high, because if it got too high, why, then, the recovery was way down again to about 50 percent. So we called it a "black roast" and made very good recoveries. Later on, they did put in a roaster up there at Trojan and operated that until the supply of gas for the mine ran out. They couldn't get enough gas out of the reserves that the city was using, so that ended that project up there.

Swent: Bald Mountain?

Johnson: At Bald Mountain.

Swent: You were grinding and then roasting?

Johnson: Yes. We were grinding to a not-too-fine degree, but then that was roasted and then quenched. The quenching cracked the particles and freed the gold, and we were able to get over 90 percent recovery.

Swent: And then you did cyanidation after that?

Johnson: Yes, then it was cyanided after that. So that was my thesis for a master's degree.

Swent: What happened to a thesis in those days? Was it used? Was your work used any place other than at Bald Mountain?

Johnson: No, because that was the only place there was this particular ore.

Swent: I see. It was unique.

Johnson: It was different, you know. Then, for my thesis for the Engineer of Mines degree, I wrote a thesis that covered the Keystone District as a mining district.

Swent: How did you happen to choose that?

Johnson: Well, I became interested in Keystone because of the fact that while I was teaching there at the School of Mines, I met a man who came in from back East to study the deposits at Fairburn of fuller's earth. They found out they weren't extensive enough, so they did nothing about it.

Swent: What was his name?

Johnson: Harold R. Eyrick. While he was in the Rapid City area, he came over to the museum, and this was during the summer of '23. I had a job with the School of Mines taking care of the work there in the museum. I showed him around, showed him some of the gold specimens, and he became quite interested in the gold samples. He asked me if I would go up there with him to Keystone and sample the deposits that were available, because he might be able to do something with it. We spent two weekends sampling and then had them assayed there at the mine experiment station.

The 1920's

A. I. JOHNSON CELEBRATES 90th BIRTHDAY

A special Open House was held February 19th at the Keystone, SD, Masonic Lodge to honor Arthur I. Johnson (Met22) on his 90th birthday.

A.I. Johnson was born in Lead, SD, February 20, 1899, the year of the first Packard car, Coca Cola was first bottled and Aspirin was discovered.

Since his graduation from SDSM&T in 1922, he has had a distinguished career in mineral processing. He is particularly noted for his work in extracting valuable minerals from Black Hills ore.

"A.I.", as we all call him, opened the Ingersoll Mine near Keystone for the recovery of beryl and lapidolite which were critical minerals required during World War II. He also participated in building mining plants in Tinton, Deadwood and Spruce Gulch.

He was involved in preliminary research for converting lithium ore into lithium crystals and beryllium ore to beryllium salts. He has also done work with gold, tantalite, spodumene and mica. He worked on survey and development of the bentonite deposits in the Belle Fourche area and on similar projects during the uranium boom.

A.I. has been a member of the American Institute of Mining, Metallurgical, and Petroleum Engineers (A.I.M.E.) since 1920, and served as S.D. State Mine Inspector from 1967-71.

In 1983, A.I. was inducted into the Western Heritage Hall of Fame for "his pioneering effort and leadership in fields that contribute to South Dakota heritage".

He was selected as one of the SDSM&T Centennial 100 Alumni honored in 1985 for Distinguished Achievement in his chosen field.

A.I. also received the 1987 Dakota State College Award for Distinguished Contributions to the Preservation of the History of S.D. and Dakota Territory.

Besides his professional career, A.I. has been active in the Keystone community serving on the school board for 37 years and as a trustee of the Keystone-Mount Rushmore Sanitary District.

A.I. Johnson is truly the "Dean of Black Hills Mining" and has been for many, many years!

A.I. and his wife, Willmeta, were married September 12, 1929, and have lived most of their lives in Keystone. They have two daughters, Carolyn Hedegard of White Bear Lake, MN, and Susan Prahl of Redding, CA, four grandsons and a granddaughter.

Their daughters were hostesses for the Open House.

A. I., Willmeta, Carolyn and Susan

II A CAREER AS A METALLURGIST IN THE BLACK HILLS

Keystone Arsenic Company

Johnson: As a result of that, he went back and financed the Keystone Arsenic Company. I was hired to build a smelter for him, which was really not a smelter; in a sense it was a roaster for roasting the ore that had the arsenic. We found out from our sampling that there was over 4 percent arsenic in the ore.

Swent: So this was a gold ore--arsenopyrite.

Johnson: A gold ore, arsenopyrite. So they raised enough funds to build a roaster there to produce white arsenic, and I was asked to take charge of it and develop it and design it and supervise the construction. So that was my first experience out in the world developing a plant that would produce something in a metallurgical line.

Swent: Where did you get your equipment?

Johnson: We renovated a mill. We took over an old mill known as the Bluebird Mill that was free-milling and had plates in it, went to Denver and arranged to get a couple of Ruth flotation machines, and put in flotation with it, and made a concentrate that had all the arsenic and that was amenable to treatment in this reverberatory. We had to build a reverberatory furnace and that was all in part of the design.

Swent: Did you make some of these things here?

Johnson: No, we ordered them all out of Denver. I made several trips to Denver and arranged to get equipment here. We had to put in

flotation equipment, of course, into the mill, and we had to buy all the material. Some of it, of course, for a reverberatory furnace, is mainly high-grade brick, you know. The rest of the material we got in this area, so we didn't have to do too much in the way of going a long ways out for it. So they operated the smelter, or the unit that produced the arsenic, there for less than a year, for the price of arsenic dropped from thirteen cents a pound to three and they couldn't make any money at it, so they closed it up.

Swent: Why was there a demand for arsenic?

Johnson: The demand fell.

Swent: What was it used for?

Johnson: It was used to kill the boll weevil. The boll weevil was ruining all the crops in the South, for cotton. So, as a result, there was a big demand for material of this kind which would destroy the boll weevil. Well, they got the boll weevil under control, and the price dropped, and, as a result, they had to close the plant.

Swent: What did it do to the workers in the plant?

Johnson: You mean the closing of it?

Swent: Well, both, but the arsenic?

Johnson: Oh, the arsenic. Well, in the reverberatory furnaces, it went into a long tunnel-like deal and was precipitated as a fume. I got poisoned there myself, and I was hospitalized for three weeks. It took me almost two years to recover from the results of that arsenical poisoning, but I've made the grade. One of the workers, Oscar Sagdalen, suffered bad burns on his face.

When the plant was closed, I didn't know what to do, because they didn't have any finances to keep me on, so I got a job down at Inspiration, Arizona, with the Inspiration Copper Company. They had a problem where they were being sued for over several million dollars on account of the method of feeding reverberatories. With my experience with the reverberatory, I thought I could handle it, so I got what was called a short-term job--it wasn't permanent--and worked out the details of firing, of handling a reverberatory furnace. We found out that the method used was the only efficient one that could be used. We tried various methods. The feeding of the reverberatory was very peculiar that there was only one method of feeding a reverberatory, but that's what we discovered.

Swent: And what was that?

Johnson: That was what they called an "end feeding." We tried side feeding; we tried top feeding. This was an end-feeding system. When that job ended, then I was again on the loose looking for a job. I got a job down at Texas A&M on the faculty.

Swent: How did you happen to get that?

Johnson: Well, I had a friend that was one of the teachers at the School of Mines that was teaching there. I wrote him a letter, and I said, "I'm just out of a job. I'm going back home and look for another one." He wrote, "Well, there's an opening here, in the civil engineering department. Why don't you write them?" So I did, and I was employed and got the job on the faculty there. But I got hay fever so bad that I came up north to recuperate.

Then I decided I would go down to Keystone to see what was going on. Eyrick was back, and they had raised funds to finance a treatment of the gold ores there. So he asked me to design a cyanide plant. That worked naturally into my back experience, because I had worked in these different sections at the Homestake. So I accepted that and resigned from the faculty at Texas A&M and went to work, first doing a lot of laboratory work to determine the conditions necessary for it.

Bullion Mine, Pioneer in Countercurrent Decantation

Swent: Where did you have your laboratory?

Johnson: I had a laboratory right here at Keystone. The company built a laboratory for me, and I did the testing of the Bullion ore, which is the mine they had leased right here at Keystone.

Swent: That was the name of the mine, the Bullion Mine.

Johnson: The Bullion Mine. So I worked at that project for almost two months before I got all the details worked out.

Swent: Did you get any help from the equipment companies? Did they help you with research at all?

Johnson: Not of any kind, no. Well, I had done so much testing with cyanide that I felt that that was down my alley anyhow.

Swent: I was wondering if you traded information with other metallurgists.

Johnson: No, it was all from the word "go" with our own problems. I tested that, and then in order to verify the possibility of the method not working, we heard about a plant up in Canada that was treating ore in the--

Swent: Now, how did you hear about that?

Johnson: Well, it was sort of through an article in Engineering & Mining Journal--that they were operating a specific kind of cyanide plant, which was called the--it wasn't sand-slime separation, but it was a method that used what we call--let's see, what is the name of that?

Swent: Was that the countercurrent decantation?

Johnson: Yes. Countercurrent decantation. [chuckles] Couldn't think of the word "counter."

Homestake has finally come to that itself. When I was working for Homestake, they had the sand-slime separation. They separated slime at Lead and it went down to Deadwood, to the slime plant.

Swent: So you learned about this first through an article in the E & MJ?

Johnson: No, I don't know how I got the information about a countercurrent system, but I finally found out that there was a plant of that kind up there. So I called them up, and the superintendent--I can't think of the name of the company, even, anymore--told me that he didn't see any reason why it wouldn't work if the ore didn't have too much arsenic in it. He said that if you got too high on arsenic, why, the gold would be precipitated. So he said, "You've got limits there and you have to decide, really, whether or not it will work. So I went back to the laboratory, and we found out that there was no reprecipitation, because we were able to get extraction in less than twenty-four hours. He said, "If it's going to be twenty-eight, thirty hours, you won't make it." So it worked out nicely, and on the basis of all that, we decided to build a plant.

Swent: Was this the first one of that kind here in the Black Hills?

Johnson: That's right. The first one of its kind I think also in the United States.

Swent: You did it even before Homestake did.

Johnson: Oh, yes, a long time, because that was in 1924, '25, and Homestake just built theirs in the last few years, you know--I mean, modified theirs. So I had quite an interesting experience there and had to design the plant, of course, to take care of the problem as it came. We operated that plant for almost two years before we had a fire that burned the mill down. Well, we proved definitely that there were no problems at all from the arsenic, if we kept our treatment time down.

Swent: What caused the fire?

Johnson: There was an explosion. It was in the middle of winter--January 5, 1930. I even remember the day. We were using a distillate burner type of a firebox to heat the mill, and for some reason or other, it got plugged up, and then there was a surge charge of this distillate. That caused an explosion, and before we could get it under control, the whole mill was on fire. So that closed that plant down.

Swent: They couldn't afford to rebuild it?

Johnson: Well, during the Depression period they couldn't raise the money. So I decided I would go in and work as a consulting engineer. They kept me employed for another year doing work on determining the gold ore reserves that were available in the mine, and I did that. Finally, because they couldn't raise the money, I went out on my own and got various contacts that made it possible to continue as an engineer.

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Swent: So that was the first fire.

Johnson: That's right.

Swent: I think fires are going to be kind of a recurrent theme here, aren't they?

Johnson: They sure are.

Peerless and Etta Mines: Spodumene, Feldspar, Mica

Swent: So you were out on your own and this is early Depression?

Johnson: Yes, that was in the 1930s, you see, in '31. I managed to find work in the nonmetallic producing of feldspars, because when we came to Keystone, there was a group that came with Mr. Eyrick. He had married one of the family, and so they were operating the Peerless Mine. There was another group operating the Etta mine, so I got work with--

Swent: Now the Etta Mine, you said, was the oldest mine--

Johnson: In the Keystone District. It was discovered in 1880.

Swent: And these were both feldspar?

Johnson: The Etta Mine was a spodumene, which is a lithia mine--lithia ore producer. The Peerless Mine was a feldspar mine producing also a lot of mica.

Swent: What were these things used for?

Johnson: The lithium at that time was of interest to the company known as--let's see, what was the name of that? Rheinbold. Rheinbold Metallurgical Corporation in Omaha were shipping spodumene from the Etta Mine down to Omaha, and they were making it into a product known as lithium citrate, which was used for medical purposes, to cure rheumatism. There was quite a demand for that, and Rheinbold came up here himself and spent a lot of time. There's a mine up here known as the Hugo, and that was named after Hugo Rheinbold. That later became one of the large producers of feldspar; also amblygonite, a high-grade lithium ore. Then I had occasion to make reports on several mica mines in the Custer area and became quite interested in that phase.

Swent: What is mica used for?

Johnson: Mica, at that time--they were producing sheet mica, which was used as an insulator and also in electronic equipment. The scrap mica was ground down, and it was used as a filler in tires, and used in wall paints and various other things, to take a fine-grained material and add a sheen to it, and it would cover well with any paint you had, you see.

Swent: And this area is really one of the best sources of mica?

Johnson: It was. In fact, during the Second World War, the government had a station in Custer that produced sheet mica specifically for their purpose. The scrap mica, of course, went to several different companies that were using small amounts. Now, for

instance, the product that we finally came to produce was what was called "screen mica" or just finer sections. We shipped that to a company in the Chicago area, and they were using that to produce mica paints and fillers, et cetera. So I built a mill over there for them to produce this crushed mica and then recovered the mica, because there was a lot of rock mixed up with it. We screened off the rock and produced the mica that was shipped as a straight mica product.

Swent: What are the problems in milling?

Johnson: In milling it, we had to control the crushing of it to a degree. For instance, we had several sections. We took the coarse mica off first and crushed the material so that the rock would go through the screen and come to another size. Then we would crush that in rolls and treat that as a separate product and screen out the waste again and so on. There were three sections to them.

Swent: How is it done?

Johnson: By crushers.

Swent: By fineness? How do you separate them? By weight or--?

Johnson: That's all. Just degree of fineness. The sand went through, and the mica being flat would be retained on screens. So that's all there was to it.

Swent: You didn't have to do any floating?

Johnson: No, no smelting or anything--just a method of crushing and sizing. That's about all it amounted to. So I was quite interested in that phase of production of mica, et cetera. Then, in 1933, a man--his wife had inherited the Ingersoll Mine up here. He came out here to find out what he could do with the mining property that they had. I was asked to take a job with him to work out, you might say, his production schedules and determine what was in the mine.

Ingersoll and Sitting Bull Mines: Lepidolite and Beryl

Swent: What kind of mine was it?

Johnson: This was a combination of feldspar, mica, lithium, beryllium, et cetera. There was a paper that I wrote on it there [indicating

document][1], and we were asked to produce lepidolite. Lepidolite is a lithium mica, and it was used in what we call nonbreakable glass. You use this as one of the fusion products. You fuse it to a product that will produce a mixture that then is made into a particular type of glass. So this was the only mine in the United States that could produce it. They had a market for it, and I developed it for that particular group. We finally built a mill there, later on, to produce it, because the hand-sorted material that we produced first was crushed by the Consolidated Feldspar up here.

Swent: How did you do hand sorting?

Johnson: Well, it was crushed, and then it went over a belt. Then you would pick out the high-grade pieces.

Swent: Who picked it out? Who were you hiring to do this?

Johnson: Well, we were hiring women to do that. They would sort the material off the belt, and the high-grade material went into a bin. The other went into a stockpile, a bin that was emptied and stored.

Swent: Why were you hiring women to do this? By choice?

Johnson: They could be paid less wages for sorting. [laughs] So that was sort of the basis for it, I think.

Swent: You could get them cheaper than you could men.

Johnson: Yes, for just picking off of a belt. They didn't have to go in the mine, and mine, and do all the hard work. They could sit there next to a belt and pick out the high-grade and let the rest go into a waste bin.

Swent: How much were you paying at that time? Do you remember?

Johnson: Oh, gee, I don't remember. Let's see. I think we were paying miners five dollars a day, and I think we paid the women three dollars a day.

Swent: Were there any sorts of benefits at all?

Johnson: No.

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[1]See appendix, "A Mine with More Varieties than Heinz has Pickles: The Ingersoll Mine, Keystone, South Dakota" p. 69.

Swent: What about health protection? Was there any thought for that?

Johnson: Well, there wasn't any need for this, because it just was on a belt in an open area. Of course, I don't think there was any health law of any kind.

Swent: No consideration about that at that time?
Johnson: No, I don't think so, not at that time.

Swent: Did the women wear any sort of protective gear?

Johnson: No, because it just moved over slowly on a belt, and they would just pick out the pieces that were high-grade, as we called it, that had over, say, 75 to 80 percent lepidolite in it. Lepidolite is associated with feldspar. A lot of it wasn't broken down fine enough to free the quartz and the feldspar.

Swent: So you could just tell by looking.

Johnson: It was all visual.

Then, another job that came up at the same time--there was a company back in, I think, Pennsylvania known as Brush Beryllium. They were interested in beryllium ores, and that was just a waste product up here at the Ingersoll, although one company at the Peerless Mine had been kind of saving all that separately, because they didn't know what it was used for, but it might become useful. This man Brush that came over was the president of the Brush Beryllium, and he wanted a shipment of beryl ore, up to ten ton if he could get it, because he was doing experimental work. So Black Hills Keystone Corporation agreed to ship him a ten-ton car, and we got half of it from the Sitting Bull Mine and half from the Ingersoll. We produced exactly twenty ton and shipped it to him instead of ten, what they needed.

Swent: What did they use beryllium for? Or beryl?

Johnson: Beryl--they were taking the ore beryl, and they had worked out a process whereby they would separate the beryllium, which was about 4 percent of the total ore, into a material that was later used in the atomic bomb. At that time, they were having a lot of trouble, and he was experimenting. The metal beryllium was so brittle, if you dropped it, it would shatter into a thousand pieces. So they were working on this ore to get to a product that was more or less annealed and amenable to forming, and so on.

Swent: So you were shipping a concentrate--

Johnson: Of beryl, which was sorted out of the ores of the pegmatites. These were pegmatite ores.

Swent: Again, was this simply a mechanical concentration that you were doing?

Johnson: Right. That was mechanical.
Swent: So you weren't really getting into a metallurgical process.

Johnson: No, no metallurgy. It was all mechanical. We produced this material by hand-sorting methods and then, later on, I built a mill to process the material that lay here way back, about ten years ago, right here at Keystone, based on the work done by the United States Bureau of Mines at the School of Mines laboratory. I designed a mill and supervised its construction here at Keystone to produce beryl concentrates from low-grade ores, later on. That was a metallurgical problem there, of course, because we had to take the low-grade ore, and it had to be crushed and sized. It had to go into flotation machines, and then after flotation it was separated as a feldspar beryl product, and the beryl then separated in another set of flotation machines, so it got quite involved.

Swent: And when did you do that?

Johnson: That was in the sixties. That was quite a bit later, but I just jumped a step ahead there.

Swent: Well, one thing leads to another.

Johnson: It sure does.

Swent: So then you shipped him his twenty tons, and that was all he wanted?

Johnson: That's all he wanted, and then the Brush Beryllium Corporation, of course, continued its work. It became the principal user of beryllium ores in the United States.

Swent: Did they continue to get them from here?

Johnson: They got all they could get from here, and during the Second World War, for instance, there was a lot of material that had the mica in it that had beryl. We separated that, and then it was hauled to an outfit in Denver that separated it to a degree. Then they shipped the product to Brush Beryllium. Well, now I've gotten quite a ways ahead.

Swent: Yes, we're in the middle of the Depression still. We haven't gotten quite up to the war.

Johnson: Yes.

Swent: Next was the Golden Slipper Mine, I think.

Johnson: Yes. For instance, I go into--1933, I think, is when the price of gold was raised. I have to check that date.

Swent: I think it was '34.

Johnson: Well, whatever date it was, at that time, there became an increased interest in gold ore again. I was asked to design a plant for a company up in Deadwood known as the--let's see, what was their name?

Frerichs Mining Company, Gold and Silver

Swent: Frerichs?

Johnson: Frerichs Mining Company. I was asked to design a seventy-five-ton cyanide plant for the Frerichs Mining Company up there in Deadwood, up in the gulch west of Deadwood--what is it, Keeler Gulch or something like that. That isn't quite the name, but anyhow, it's west of Deadwood about a mile--in that gulch. So I designed that plant and got it into operation and trained the operators so that they could produce a product from that plant. We had no individuals around there that ever had any experience, so I had to train all the operators and get them familiar with the metallurgy and so on.

Swent: What kind of plant was it? What were you using? What method?

Johnson: The cyanide method. It was using a countercurrent, same as the other. Countercurrent method.

Swent: And you ended up, then, with a concentrate?

Johnson: No, a bullion. A bullion product.

Swent: And what did you do with that?

Johnson: That was shipped to Denver to the mint.

Swent: Directly to the mint.

Johnson: Directly to the mint.

Swent: How did you ship it?

Johnson: It was shipped by express.

Swent: On the train?

Johnson: Yes. It went, I suppose, delivered to the express company and shipped from there, similar to what we did here. When we operated the cyanide plant, we shipped the product directly to the mint by express.

Swent: Railway Express.

Johnson: Railway Express, and they insured it, of course, et cetera.

Swent: How did you guard it?

Johnson: Well, we didn't seem to worry about that. We didn't figure anybody knew enough about what gold looked like to worry about it. We produced our bars of gold, and when they got the bar ready, we would ship it.

Swent: So you had a little refinery.

Johnson: Well, we had a small refinery of our own. We would take the precipitate from the cyanide plant, and mix it up with the necessary reagents, and smelt it, and then when we got through, we had a bar of gold with silver in it, you know. So at that time--that was in the thirties.

Swent: So you were living in Deadwood at that time.

Johnson: No, I lived here, but I worked back and forth. [chuckles] I would drive to Deadwood. That was when my wife was raising the family and I was on my own "out in the wilds," as they say.

Swent: Driving must have been something in those days, too.

Johnson: Oh, I should say. Well, that wasn't as bad as some of the driving I did later, when I was doing work at Tinton, which I did about the same time. I was going on to that next.

Tinton District: Tantalite and Lithium

Swent: Oh, yes, the drive from here to Tinton in those days was really something.

Johnson: Yes, so I stayed up there overnight and for a whole week at a time. Back in nineteen twenty--let's see if I remember the date now. [pause]

Swent: We can always fill in these dates later.

Johnson: Yes. Well, I've got it pretty well on the tip of my tongue if I can relate it to one thing or another. Let's see. In 1936, the Fansteel Metallurgical Corporation of North Chicago became interested in finding a source of tantalite in the Black Hills. They were producers of tantalum metal, and they had a man from Germany by the name of Balke, the chief chemist that worked out the details of producing the metal tantalum. So they had to have ore, but they were getting it from West Australia, which meant a long haul and a long wait. They had decided that they would investigate the possibilities of a source in the United States.

So in view of the fact that they wanted to get a source of the material in the United States, the question was where to get it from, you see. In view of my experience with previous work in mica, feldspar, et cetera, with the pegmatites, I was hired as their engineer to investigate the possibilities of producing tantalite from the Black Hills and from other areas in the vicinity. So I investigated the possibilities in the Black Hills. We found out there had been some ore shipped down in the Custer area. We found out, of course, the mine up here, the Ingersoll, had produced it. Then, also, we had the production record of some being produced from the Peerless. So we investigated all those, and they made a deal to investigate by mining methods this area down in the Custer vicinity known as the Beecher Lode. We worked that. I supervised the operation of it for a while. Then we investigated the possibilities at Tinton. They had developed quite a source there.

Swent: There had already been an old mine there, hadn't there?

Johnson: Yes. John Bland had built a mica plant there in 1928, and he found out he didn't have enough mica reserve available, so he took time off. He closed the mill and decided they would investigate the possibilities of getting more mica. In doing that, they ran into these tantalite deposits, which was called later Tantalum Hill. I went up there and investigated that and made a geological study of the possibilities. They decided, on the basis of my recommendations, to lease the mine up there at Tinton and go into production there.

Swent: It must have been called Tinton because they had tin there.

Johnson: They had tin ore which had been developed way back in the 1880s. They had a tin mill that operated in about 1895 on to about 1910. That was the reason for the name Tinton.

Swent: I wonder why they had stopped.

Johnson: Well, the problem there was that they were getting such low recoveries. The methods they were using, they were getting about 50, 60 percent of the total product.

Swent: So the difference was that you had better technology now?

Johnson: Yes. So what they wanted to do was to find a method that they could get more extraction of the metal they were spending their time and money to mine it, you know.

Swent: So it wasn't a new discovery of ore but of metallurgy.

Johnson: That's right. So John Bland came up there in the twenties. He built this mill in '28 to produce mica. That's all that he was going to get out of there. As a result of the fact that they didn't have enough ore reserves available, he went into Tantalum Hill, and they produced somewhere in the neighborhood of fifteen, twenty ton of tantalite, which was shipped to Blackwell in London. They were the ones that were using it for some reason or another. I don't know what it was used for. When he got through that operation, he ran out of funds, because a man named Beatty in Chicago was financing him, and he figured John was spending too much money. They closed the place down.

As a result of that work, I was asked to design a milling plant for the Fansteel Metallurgical Corporation to produce tantalite, and so I took the lower part of the mill that John Bland had built and converted it into a concentrator to produce tantalum concentrates. We shipped this concentrate, then, to North Chicago. It was mixed up with a certain amount of cassiterite, or tin ore, and then we also had a placer operation producing tantalite from Mallory Gulch. They produced over twenty-one ton of concentrate and proved definitely that there was available a resource in the Black Hills. I also investigated the possibilities in Wyoming and Colorado and even got down to New Mexico to look over some deposits. But the best one they found was the one at Tinton which we put into operation and set up a milling process for it.

Swent: What was your process for that?

Johnson: That was just concentration. We took the ore, crushed it in the plant that was used for mica, the crushed product went down into a jig, which was a unit that vibrates with water, you know, and made a jig separation. Then the tailings from the jig went down into Wilfley tables, and that's what we used to make a concentrate of tantalite mixed with the tin, of course.

Swent: And you were able to use most of the equipment that was already there?

Johnson: Yes, we were using the equipment there. Well, let's see now. That covers that.

Swent: Did you use up all the ore? Why did you stop?

Johnson: Well, we went into production there in the mine. We sank a fifty-foot shaft, put in tunnels and drifts and stopes, and so we produced the material directly from mining operations.

Swent: And were you in charge of the mining as well?

Johnson: I was in charge of the whole thing for them.

Swent: Why did you stop?

Johnson: Well, the reason for closing the plant was that they had a fire there. It burned the mill down.

Swent: What caused this one?

Johnson: Well, we had a dryer unit set up in one end of the mill. When the product came off the tables, we had to dry it before we shipped it. Due to some explosion in the burners, why, it started a fire. Before they knew it, it was all spread over. That closed the Tinton operation down until the Second World War, when I designed another plant for Beatty's Black Hills Company, to produce spodumene, at that time, and then a byproduct of tantalite. It was financed through Reconstruction Finance Corporation.

Swent: Fires are a mill man's nightmare, aren't they?

Johnson: Oh, I should say so. We had this fire in Keystone, and then the dryer fire at Tinton. Everywhere you went, there was a fire.

Swent: Yes. It's always the thing you're afraid of, isn't it?

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Swent: So L-208 [War Production Board order L--208 closed many mines in 1942] did not affect this?

Johnson: No.

Swent: Was spodumene a critical mineral?

Johnson: Yes. Spodumene is a mineral that runs around 4 to 6 percent lithium. At that time, in 1942, is when L-208 closed the gold mines, but it didn't affect the spodumene because they were in need of lithium for the war purpose. They made lithium hydride which was used as a signalling device. With a little water added to lithium hydride, it produces hydrogen and inflates a balloon, and they can signal. For instance, a man on a plane that was grounded, he could send these signals up and give them his location. So lithium carbonate was used at that time and for the purpose, primarily, of producing a lithium hydride.

So the War Production Board asked the Beatty Corporation to go ahead and undertake the building of another mill, so they were financed by this particular corporation, of course. So I designed another plant situated near the spodumene and tantalite deposit, near the mica deposit, and put this building into operation. We produced spodumene concentrates from it by flotation. I did a lot of research work on that, and, assisted by the Bureau of Mines, we worked out a flow sheet. Then I built the plant according to a generalized flow sheet that we had and put into operation and produced lithium concentrate during a period of the war and tantalite as a by-product.

Swent: What sort of help did you get from the Bureau of Mines?

Johnson: The Bureau of Mines had worked out a lot of details in the method of extracting ores from pegmatites. They had a generalized laboratory. They could work on any particular product from pegmatite and try and refine it, so one of the principal ones they worked on was, of course, beryllium, because that was needed for the atomic bomb (which we didn't know at the time). They had done some work on the lithium, too, so we set up a laboratory at Tinton there. I did a lot of research work there to produce the lithium concentrate by flotation. After we got all the details worked out, we built the mill accordingly.

Swent: Did the Bureau of Mines provide personnel to you?

Johnson: No, they had their own--it was just laboratory work, same as I did up there at Tinton.

Swent: You just traded information with them?

Johnson: Well, they gave me all the information they had, and then we worked on the basis of a combination of facts from here and there and developed a process for it.

Swent: Then they had access to your information also.

Johnson: Oh, sure.

So we operated that during the war, and then after the war ended, why, the Beattys leased the property to the Bald Mountain Mining Company which was up in the Northern Hills.

Swent: You had worked for them before, long ago.

Johnson: Yes, but this particular operation was entirely their own. They went into production of lithium minerals and every other mineral that they could. On account of the fact that the government had closed the gold mines, they had the personnel available, so they used that. And that mill burned down. We had designed the plant in such a way that it couldn't burn down by building a concrete barrier between where we were firing the dryer details and so on. Instead of that, to make it easier for them to get around, they cut a hole through the concrete. It was just like having a shaft up through there. When the fire started, it started that circulation of air, and it went up and burned that mill down. So that was the second mill up there. That was one fire after another.

So anyhow, we did a very good job of it during the time we were producing, during the war, you know. Then Bald Mountain came in, and that was the end of that again. Since then, Tinton has been sort of waiting for somebody to come and open it up, because they do have a lot of mica reserves. They have lithium in their reserves, et cetera, and feldspar.

Swent: It's a question of economics.

Johnson: Yes, and that's the end of that particular area--story. Let's see, where are we now?

Swent: Well, you came back to the Holy Terror. That was earlier.

Johnson: I built two spodumene plants as a result of my work in Tinton. I built a spodumene plant in Keystone and converted a gold plant into a lithium plant here. We put in flotation equipment. We put in dryers. This plant operated during the period of World War II for a little while and then into the period after the war even.

Swent: So the mechanics are the same whether it's gold or mica or whatever?

Johnson: No, the crushing is the same. You crush it all down to a certain size, but from then on, it's entirely different. Instead of into cyaniding, you go into flotation. You make a flotation concentrate, and you have to treat that. Later on, you extract the metal out of it, you see.

Swent: So when you say you convert a mill from one thing to another, it's not that simple.

Johnson: It sure isn't, because we had to take out certain equipment that was in the way, and we had to put in other equipment. For instance, in the treatment of gold ore, we didn't need any dryers, and we didn't need any flotation equipment. We had to make space for all of that.

Swent: What role did the equipment salesmen have in all of this? Did they come around and talk to you?

Johnson: No, we were in a specialized field, and every time that we needed certain equipment, I would make a trip to Denver and discuss it with Denver Equipment Company or Hendry & Bolthoff.

Swent: They weren't coming around to you?

Johnson: No, because this was entirely different.

Swent: So Denver Equipment and Hendry & Bolthoff.

Johnson: Hendry & Bolthoff. They were equipment companies there in Denver that knew all--where it was available, the facts about it.

Swent: What kind of things were you buying?

Johnson: Well, flotation equipment, for instance. Denver Equipment had its own flotation equipment. Hendry & Bolthoff operated their plant on equipment from other makers of different flotation equipment, you see.

Swent: You mentioned Wilfley tables.

Johnson: And Wilfley tables were made. They're a standard product, because they've been used since the turn of the century in concentrating. All it is, is a shaking table with riffles in it, and then the coarse material that won't flow off easily gets concentrated into the riffles and moves gradually off to one end.

Swent: What kind of grinders and separators?

Johnson: Oh, we use ball mills, jaw crushers, and ball mills.

Belle Eldridge Gold Mines

Johnson: For instance, I might give you some information on changes I made over in the area up Spruce Gulch for the company known as the Belle Eldridge Gold Mines. They were a gold mining company up in Spruce Gulch. During the war, there was a demand for lead and silver, you know, particularly the lead. So there was an area in Spruce Gulch that was very high-grade ore that could produce silver, lead, and gold. They had a gold-milling plant there that had been built way back in the early 1900s, so I was asked to convert that over into a flotation unit that would produce the silver and the lead.

The problem there developed into a headache from the standpoint of the fact that there was a lot of another metal in there that was detrimental to the lead, and they couldn't use it with it. That's the zinc. So I had to work out a differential flotation, as we call it, whereby we separate one metal from another in a flotation process. Instead of having a small ball mill, we made a trip back to Milwaukee and got a three-foot cone crusher which made it possible to treat more ore, because this was only a fifty-ton plant, and we had to get it up to a hundred. So we put in the three-foot cone crusher.

Swent: What kind of crusher was it?

Johnson: Symonds cone, three-foot diameter.

So we produced the ore from the mine and then made the separation of the lead, zinc, and silver, and shipped the zinc concentrate and the lead concentrate. The lead concentrate had all the silver in it, of course.

Swent: Where did you ship them to?

Johnson: They went to Omaha, to the Omaha smelter there.

Swent: Who owned the Omaha smelter? Was that AS&R?

Johnson: American Smelting & Refining, yes. So that's another change of a plant that was a gold plant into processing different kinds of ore.

Let's see. Where are we now?

III OTHER ACTIVITIES

Owning, Leasing, Managing Mines

Swent: You yourself have picked up some claims here and there.

Johnson: Oh, I got those after all of the mines closed down one time or another. When something came up, why, I had an opportunity like--for instance here, I bought the Bullion and the Columbia Gold Mines after the gold situation got bad and nobody was putting any money into gold. I bought that, so I own it. At the present time, I'm trying to lease it to several companies. Homestake had a lease on it for about five years. They didn't want to pay any more royalty than we were getting, so we transferred it to another company known as Beau Val. They ran short of funds, so I have it back now, and I'm working with another company. That's the Bullion group. Then I had some other properties in the Custer area that were producing, that I arranged to get an interest in. So all the way around, I've got, here and there, properties. When the Belle Eldridge closed down, and they were shutting it down, I made a deal to buy that. So another man from Spearfish and I located the Belle Eldridge Gold Mining claims, and we have those now. So I have gold mining claims up there, and up in the Keystone area, and then others over in the Custer area.

Swent: Have you ever operated any of these yourself, or do you just lease them out?

Johnson: I just lease them out. It runs into quite a problem. For instance, I was interested in a mine over at Custer, a mica producer known as the Mineral Mills Company, which was a company that we used to operate it with. But we produced mica during the war from this particular property, and then later I built this mica plant there to produce crushed mica. Then we also had women working in sheeting and rifting plants in Custer, Hill City, and

Deadwood. So I was involved in that personally, but I'm trying to just more or less lease these properties out to individual companies.

Swent: Did you ever do any prospecting on your own?

Johnson: Oh, yes, I've done a lot of that, of course. During periods when I wasn't doing anything else [chuckles], I would take off.

Swent: Did you stake claims and do any of that?

Johnson: Well, I made deals, which I've been able to sell--some of the properties--sold them.

Well, now, let's see.

Mrs. J.: Reports on small mines.

Johnson: Yes. For instance, up here we're operating a mine known as the Juniper Mine. I made a deal to buy it out from the people that owned it, and later on I got a company to come in there, and they built a mill. That was a gold mine, of course. We operated that until that air base out here was built. We lost all our employees. They got ten dollars an hour instead of five dollars an hour, and so we haven't been able to get it started. But we have it leased now to a company in Denver by the name of Boulder Gold. I was interested with some people there at the Golden Slipper--they were a company that I built the mill for, a company known as the Empire Gold Mines, represented by an individual that came from back East. I renovated their shaft and got their mine into operation, cleaned up the drifts, and got a mill built for them. A man named Uppercue from New York came in and made a deal for the property. He operated it until they ran pretty low on ore. I guess he's dead now. Recently, we leased that to this company known as Boulder Gold, so I have an interest in that with the people that originally owned it.

Swent: So getting employees is sometimes a problem.

Johnson: It really is. It isn't simple, and to get somebody that's trained. You can't take an individual off the streets and put him into a mine and have him start mining.

Swent: What about housing? Did you ever have to provide housing for anybody?

Johnson: Well, up there at the Golden Slipper, we had to build housing, but that's the only place. Out there in Tinton, they already had

those houses that were built way back when they were operating in the 1920s, in that period.

Swent: So you generally just picked up local workers.

Johnson: Right, and then they would have to come to the operation.

Swent: How do you hire people? Do you put ads in the paper?

Johnson: Well, usually, you've got people looking for work always.

Swent: Just word of mouth.

Johnson: Yes.

Swent: So, I guess we're up to the time after the war.

Exploring for Uranium

Swent: Uranium then came into the picture.

Johnson: Well, I worked quite a while during the period that uranium was uppermost in everybody's mind. I did a lot of geological work on that for people in different areas. I worked in the area down north of Edgemont, and I did some geological work for people down in New Mexico and also in Wyoming, particularly a lot of it in Wyoming. But all that was geological work, which I did in working out ore reserves. That was a little bit different from the metallurgical. Of course, I fitted in with my mining degree.

Swent: Did you enjoy that?

Johnson: Oh, absolutely. It was very interesting. A lot of frustrations in some of it. I remember one mining area over there in Colorado. We ran into some problems there in our research. We found out that the ore was so much different that in order to extract the metal, you have to use an entirely different process. People didn't think that they were able to work that out. I didn't have any time for it, and that was way over in western Wyoming.

Swent: What process were they using?

Johnson: They were using what was known as a leaching process.

Swent: Acid leaching?

Johnson: That's right.

Swent: And it didn't always work.

Johnson: It didn't always work, see, and this was the problem they ran into, where they couldn't get extraction.

Swent: So they just gave it up?

Johnson: They gave it up, and I don't know if anybody's done anything with it.

Swent: Where was this?

Johnson: This was up in southwestern Wyoming, over at--the name of the place was--hmm. They had a little town there. [pause] Can't remember.

Swent: There's uranium around Lander.

Johnson: Well, this was south and west of Lander. I can't think of the name of that town.

Swent: That's kind of a depressed industry, of course.

Johnson: Yes, and I don't think there's anything been going on there at all since that time.

Swent: Where did you go in New Mexico?

Johnson: Well, around--what's the name where the Homestake--

Swent: Were you in the Ambrosia Lake area?

Johnson: Yes, did some geological work in there. And then there was another area where Homestake is. I did some geological work for a company down in that Leadville area.

Swent: In Colorado.

Johnson: In Colorado.

Swent: But you've always kept your base in Keystone.

Johnson: [chuckles] That's right. Yes, I wasn't about to change it, because we built this house here, and we decided that was home base.

Serving as South Dakota State Mine Inspector

Swent: Well, it's certainly nice. Now, you did have a period when you were State Mine Inspector.

Johnson: Yes, that was in the late sixties, I think--'66, '67, '68. I was State Mine Inspector.

Swent: How did you get that?

Johnson: Well, a fellow that was State Mine Inspector got too old to do any more, and so the vacancy arrived. I found out about it, so I made an application for it. I was hired as State Mine Inspector and held that job until the Democrats took over. I was a Republican, so I lost the job when the Democratic regime took over.

Swent: What did this job involve?

Johnson: You had to inspect every mine that was in operation in the state--Homestake, and all the other mines, and all the gravel operations, and all the sand operations.

Swent: So it wasn't only in the Black Hills.

Johnson: Oh, no. It was all over the state and over, for instance, in the areas of production of sandstones or limestones or anything that was quarried.

Swent: Were you inspecting for safety or for production?

Johnson: Well, safety. Entirely safety. [to Mrs. Johnson] What were you saying?

Mrs. J.: Marble.

Johnson: And marble, yes. Marble quarries.

Swent: Where are they?

Johnson: Over in the eastern part of the state.

Swent: So it was just safety. You weren't checking the accuracy of their production records or anything like that.

Johnson: No. That's right. I sent annual reports to the governor at Pierre--the annual report is all.

Swent: But you didn't check their reports.

Johnson: No.

Swent: I see. Did you enjoy that job?

Johnson: Well, it was interesting. It sure was. I took Willmeta [Mrs. Johnson] along, and she kind of helped me drive between places.

Swent: Were you doing any other work at the same time?

Johnson: No. This was a full-time job. For instance, I had to check the Homestake. It took quite a while to check it over completely. All of the operating areas of the mine where miners were working--you had to check their safety. In case of any accident, you had to be available.

Swent: And what about the environmentalists? Did you ever tangle with any of these problems?

Johnson: Well, the first problem we had with environmentalists was in the area of Belle Fourche. All the bentonite, of course, was mined out, and then they had pits. They had to put back the cover on it, you know. And when they got through, a lot of those areas looked better than what nature had originally.

Mining Bentonite

Swent: Did you get into bentonite mining at all?

Johnson: Yes. While I was engineer for the Keystone Consolidated Mine, there was an engineer that came in from back East by the name of Ihlseng. He got interested indirectly some way or other in the bentonite, and so we went up there to the Belle Fourche area to make a test run. He leased a mine up there, and we stripped it. Then we built a platform, a floor out of just boards and then spread the bentonite over this platform so the sun could dry it. We had no money to put a dryer in just for a ten-ton sample. I remember we were drying this at the time that President Coolidge was in the Black Hills, and they had this deal going on in Belle Fourche. He was visiting the Belle Fourche Roundup, and we took the afternoon off and went to see the Belle Fourche Roundup while the President was there. We had to watch the weather pretty closely, because if it had a rain, why, then we had to cover the platform. We finally got it dried as much as we thought we could, which was about 10 percent less than they wanted, but we decided we better not play with the weather, so we shipped it--the first ten ton of dried bentonite, hand-dried, ever shipped from that area.

Swent: Where did you ship it to?

Johnson: It went to some bentonite corporation back East.

Swent: I see. And they used it in candy, didn't they, originally?

Johnson: They were using this in de-inking newspapers. That's what this particular shipment went to.

Swent: I see. But later, bread was one of the big uses.

Johnson: That's right. Oh, yes.

Swent: Keeping bread fresh--and ice cream, I think?

Johnson: Yes.

Swent: You didn't stay with that?

Johnson: No, we made this test run and checked it out. This man Ihlseng lived here in Keystone for the summer. He was a mining engineer. Later on, I did do some work up in the area that goes into Wyoming there for a bentonite company with the idea of making reports on reserves--how much tonnage was available.

Swent: We were mentioning environmentalists. Did you ever have problems with tailings disposal or any of those things with your operations?

Johnson: No, just the only one I mentioned up there at Belle Fourche. We saw to it that they covered up the pit and made a check of that. As far as the rest of the mines, why, I don't think there was any effort at all in those days.

Swent: You didn't worry about what you dumped into the creek?

Johnson: Oh, yes. We got into a problem there. I'll have to explain that to you, too. We were milling this ore at the Holy Terror Mine, and our tailings went into the Battle Creek here. Somebody reported they had seen a dead fish out in the creek--reported that to the Fish and Game Department. They came out and investigated and said that we were contaminating the creek. So then we had to hire a chemist from down at the School of Mines, Dr. Karsten, who was head of the chemistry department, to come up and sample it and decide how badly we were contaminating the creek. When he got through, we proved that by the time the cyanide got a hundred feet out away from the mill, it was dead.

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And so we found out that there was no contamination as far as cyanide destroying anything in the creek. In fact, there was a family living down at Harney, which is about a mile and a half below Keystone, that had some cows there that they were milking. The cows had been drinking that water all the time that they were there. Nobody ever protested that.

Swent: What about the Indians? Have the Sioux Indians bothered you at all?

Johnson: No, not at all. They want to take over the Black Hills, you know.

Swent: I know, and they've caused trouble to some of the mining operations.

Johnson: They've never bothered me any.

Swent: In fact, they were camping up here just a few miles up.

Johnson: Oh, yes, over here at Yellow--what do they call it? Yellow Thunder? And the Forest Service canceled that out on them, so there's no action there now anyhow.

Mrs. J.: Some of the Indians would come. They were pretty good workers who would come and work until they got their first paycheck, and then they wouldn't come back.

Johnson: Yes, we had trouble. We tried to hire Indians to give them a job, you know, and they would work for a week or so, and then they would take off over a weekend. We wouldn't see them for several days and they would come back and expect to go to work again. We said, "No, we've got to have steady work or none at all."

Swent: So they haven't been a good source of employees.

Johnson: No, they sure haven't.

Swent: Have you had a preference, or as far as employees go, you've just taken what you could get?

Johnson: That's right.

Mrs. J.: He always said the farmers make the best workers.

Johnson: Yes, that's right. [chuckles] We could train them to do what we wanted to do, and we'd get some old-time miners, and they would do what <u>they</u> wanted to do, you know.

Swent: Some of these mines--were they operating all year round, or were some of them just seasonal?

Johnson: No, all year around. Winter and summer both.

[pause] Let's see. I can't think of anything we haven't covered.

Swent: You kept your contacts with the School of Mines through the years.

Johnson: That's right. I've worked with the heads of the mining and metallurgical department on various projects. They would get a job, and they were teaching and they couldn't do it, so they would pull me into it, and I would go ahead and do the job for them and then have them check it out with me. We would make a report on it. Dr. Gore of the School of Mines in the metallurgical department and Dr. Lincoln of the mining department, and then the geology department. So I've had a lot of contacts with the men in charge of the departments.

Swent: What was Dr. Gore's first name?

Johnson: Bancroft.

Swent: And Lincoln was--

Johnson: It was Francis Church Lincoln.

Swent: And your name is Arthur, but you're not known as Arthur very often.

Johnson: No, A.I. because there was another Johnson in here by the same name, Arthur Johnson. He was an alcoholic, and so when we got married, some people, I guess, contacted Willmeta and said they were sure sorry she married an alcoholic. [chuckles] Or words to that effect.

Swent: So you decided to be A.I.

Johnson: I decided to have a different title. Instead of Arthur, I would have A.I. so it would be definitely distinguishable that way.

Swent: What's the "I." for?

Johnson: Isaac. My father's name was Isaac.

Swent: You've done some other things. You had something to do with the land for the Methodist camp, didn't you?

Johnson: I was in charge of the company that owned it, and I made the sale for the company.

Swent: What company was it?

Johnson: Black Hills Keystone Corporation.

Swent: They owned the land.

Johnson: They owned the land that Coon Hollow was on. That's the name of the place down there.

Swent: And the Methodist church bought it?

Johnson: And the Methodist church--is it a Methodist church? I guess it is, isn't it? Yes. They bought it, and I was the one that put through the deal.

Swent: And you've been active in the Masons.

Johnson: Oh, yes, I've been involved with them since I became of age, you might say--since 1921. I've been working with them ever since, so I'm still involved.

Swent: What is your involvement with them?

Johnson: Well, I'm just a member now, but I'm still a part of it. [chuckles]

Swent: You used to do more?

Johnson: I was master of the lodge here for seven years, and then in Rapid City, I was head of the two orders there, the Knight Templars, and also I was the head of the--what's the name of that other down there?

Swent: The Shrine? Were you in the Shrine?

Johnson: Yes, I was in the Shrine, but I had no office there. The other was--

Mrs. J.: Is that Royal Arch?

Johnson: Royal Arch, yes, but they had another name for them. So I've been the head of each one of those, and then I was with the Grand Lodge for one year. So I've been involved most of the time. I headed the Red Cross of Constantine, too.

Swent: What about AIME [American Institute of Mining, Metallurgical, and Petroleum Engineers]? Has this meant very much to you?

Left: A.I. Johnson, 1986. Admission into South Dakota Cowboy and Western Heritage Hall of Fame.

Below: A.I. Johnson, wife Willmeta, daughters Carolyn Odegard, Susan Prahl. 90th birthday, February 19, 1989.

Johnson: Yes, oh, yes. I've been chairman of the Black Hills chapter of the AIME, and I was involved in organizing the Black Hills chapter of the Drill and Crucible Club in Rapid City which was part of that metallurgical group. I was one of the first secretaries of it.

Swent: You've been a member of AIME for a long time.

Johnson: Oh, yes, ever since 1920 or '21.

Swent: And Willmeta's been in the Woman's Auxiliary to the AIME.

Johnson: She's been in that for over fifty years.

More About the Early Years in Lead##

[Interview 2: August 24, 1989]

Swent: Why don't we go back and start at the beginning again, and let you tell a little bit more about what it was like growing up in Lead at the turn of the century.

Johnson: Okay. Well, I certainly recall a number of problems that I was involved with as a result of having to work more or less to keep sufficient funds to go to high school. I sort of worked my way through, and so I had a job with the school as a night fireman during the winter. Sometimes I would work on a very, very cold day up to three o'clock in the morning and then get home to bed, have a nap, and then get up the next morning to go to high school.

Swent: What were you doing? Stoking the fires?

Johnson: Stoking. I had three boilers to tend to, and to shovel the coal into those three boilers and keep them going until I thought the temperature would hold up until school started. Then, as a result of being associated with the Episcopal church and my experience as a fireman, they hired me as a fireman for the year 1916 and '17--the winter of that. So I fired an extra boiler at times. While I had three going at the school, I fired an extra boiler at the Christ Church. To get the church warm, I would get there at four o'clock in the morning on Sundays when it was very cold, and fire the boiler and heat the whole church and then keep it warm all that day. Then, on Wednesday night, they had a special meeting, so I had to fire the boiler for them on Wednesdays as well. So I had two jobs going on at the same time.

But the installations were only about a couple of blocks apart, so it wasn't too much of a problem.

Swent: How did you happen to be an Episcopalian and not a Lutheran?

Johnson: There wasn't a Swedish Lutheran church in Lead at the time, is what my understanding was, and so my mother sent me to the Episcopal church. I went there to their kindergarten down in the basement---Hearst Free Kindergarten. As I got older, I naturally just fell in line going to the church. So I was an Episcopalian until I left at the time I was inducted into the army, and then when I got to Rapid City, why, I attended that church a couple of times. They weren't too friendly, or I didn't think they were, and there was a minister that was chaplain with this mining group. He had charge of the Presbyterian church. He was the minister. So he invited two of us to attend his church. His name was Johnson, and so I decided, "Well, that would be a good place," so I sang in the choir [chuckles] while I was in the army, down there at the Presbyterian church. That was one experience I had. As long as I stayed in Rapid City, I was a member of that church. Then, when I came to Keystone, then I joined the other church there, which is the United Church of Christ now. [to Mrs. Johnson] Is that what it is?

Mrs. J.: Yes, it was Congregational.

Johnson: It was Congregational, see.

Swent: Did you speak Swedish in your home as a little child?

Johnson: Well, I must have. I don't remember too much about it, because that's what my family--both of them came from Sweden. Naturally, they would talk their own language at the time they came here.

Swent: But you don't remember any traumatic experience learning English at school?

Johnson: [chuckles] That's for sure. I sure don't. My mother insisted that I speak English.

Swent: You worked then, for a while, on the section gang. There were a lot of different people on that, you said.

Johnson: I got a job with the Northwestern Railroad on their section crew. This was in 1912, and I went over there to see the boss. I asked for the job, and he said, "Well, you look pretty young." I said, "Well,--" I kind of fibbed on it. I told him I was approaching eighteen. Well, I <u>was</u> approaching it [laughter], but I was a long way from being eighteen.

Swent: Five years for an approach.

Johnson: So I worked on the section crew most of the summer. It was while I was working on the section crew that I had an opportunity to go into the Amicus Mill and talk to the foreman there about a job in the Amicus Mill. He told me to see the old man, and I did. So the next summer, I worked all summer as a plate boy, we were called.

Mrs. J.: You had mentioned that.

Johnson: Yes, I mentioned that before.

Swent: What about the other people on the section crew?

Johnson: Oh, on the section crew, there were five men working there, each of a different nationality. I think I listed that before.

Swent: Well, after we stopped recording, though. We talked about it after we had finished taping.

Johnson: Oh, that's right. As I remember, there were five separate nationalities represented there. We got the whole sum of fifteen cents an hour. We worked ten hours a day, and we worked six days a week. We were off Sundays.

Swent: And your boss had to speak to you in all these different languages?

Johnson: He could swear in five languages. I don't know whether he could speak them all, because there was Slav, there was Montenegrin--I remember that--then there was, well, let's see here [pause]--

Mrs. J.: Italian.

Johnson: Italian. I'm trying to remember them all consecutively.

Swent: Cornish? Maybe Cornish?

[pause]

Mrs. J.: Cornish.

Johnson: Yes, one was from Cornwall. I was trying to think of this particular one. He had come over from Cornwall and had worked in the mine. He wanted to get a job with the Homestake, but they were filled up, so he got this job on the section crew as an interim job. That was very interesting, because, you know, you couldn't talk to very many of them in their own language. I

remember asking one of them who was an Austrian. I said, "You're German, aren't you?" "No," he says, "me Austrian." [laughter]

Swent: That was a distinction.

Johnson: Yes, he wanted to differentiate that. Then I also did janitor work at the school. I had a job taking care of one room at the high school there. I did the janitor work on that, and then I had a job hauling all the paper from every one of the rooms to the furnace and burning it. That was part of my job there. Then, the last two years of school, I had a job working for the--what's the name of that company? They moved out of here. They have a store.

Mrs. J.: Hearst?

Johnson: No, not Hearst. I did work at the Hearst as a boy filling the shelves with the groceries. So I worked on that.

Hearst Mercantile it was. Then this other job I had was with Woolworth's. After I graduated, they offered me a job as assistant manager. I worked at that until they closed the store and moved the store to some other place. But the manager went to a place called Lovelock, Nevada.

Swent: Well, you certainly started working pretty early, didn't you?

Johnson: Another job I had was working with a concrete gang. We had no machines to mix our concrete. It was all done with a shovel. So that was pretty hard work. I remember that particularly. I tried hard to find another job so I could get out of it, but I had to hang on to it for a while.

Mrs. J.: He should tell how he broke a leg, too.

Swent: Oh, did you break your leg at some time?

Johnson: Well, bumming a ride on a wagon, and my foot slipped and went into the wheel, and I broke my leg. I don't think I was more than about ten or eleven years old. Ever since then, that one leg has been a half-inch or more, just five-eighths of an inch shorter than the other.

Swent: When that happened, were you taken to a hospital?

Johnson: I think I was taken up to the Homestake Hospital at that time. But I remember they set it wrong, and so I had an awful lot of pain with it. About two or three days later, I called the Homestake doctor, and he came up. They put me on a table at home

and broke it again and finally set it right. It finally healed up properly, I guess.

Swent: So you did have access to the Homestake Hospital?

Johnson: Oh, yes. We had access to it all the time while we were still in Lead.

Swent: So that was some help to your family.

Johnson: That was some help to the family, because all the hospital expenses were taken care of. Then, during the early fall of 1917, they had the flu epidemic here in Lead. At that time, I was working for the Northwestern Railroad as a clerk making all the billings. There was a man that came up with the baggage car. He stopped in there, and he had the flu, and they say he died in another day or two after he left there. Well, I caught the flu, and I was in bed for a week or ten days myself. When I was inducted into the army, they put me into the hospital crew taking care of flu patients, because the theory was that if you had had the flu once you wouldn't get it again. So I spent the first three weeks or a month there in my army career taking care of patients at night. Some of them we had to tie down, even, because they were that violent.

Swent: That was a terrible time, wasn't it?

Johnson: It sure was. I remember there was this continual flow of people being taken to the cemetery and buried. So many died here.

Swent: You had mentioned Boy Scouts also.

Johnson: Oh, yes. As a result of being a member of the Episcopal Sunday school, when they organized a Boy Scout troop, it was organized by this Reverend Montgomery who was the rector at the church. He organized the Boy Scout troop, and I naturally fell in line and joined it. I was a member of that particular group which was supposedly the first Boy Scout troop in South Dakota. I remember when we were back in England on a trip, I thought I would see what I could find out about that, but they had to drive us so far out of London that we gave up seeing the headquarters.

Mrs. J.: He can't remember anybody else that was in that troop with him.

Johnson: No.

Swent: You must be the oldest one then.

Johnson: Yes, that is still in the area, at least.

Swent: Did you have uniforms and all that sort of thing?

Johnson: Oh, yes. I remember the first handkerchief had to hang around your neck, you know, as a symbol of a Boy Scout membership. Then the short trousers we wore. They weren't trousers. I don't know what you call them. Anyhow, I do remember that part. Then I got involved in a job that kept me from attending meetings. I dropped out of the Boy Scouts before I got to be a full member.

Swent: You thought there might have been a connection between Reverend Montgomery and Gutzon Borglum.

Johnson: Yes, I was told that Reverend Montgomery was father of Mrs. Borglum. That's what I've been told, and I've never been able to find anybody that could verify it or could tell me it wasn't true. That went way back to when I was going to--the Boy Scouts was probably when I was about--well, I remember joining the Boy Scouts in 1911. It was organized in England in 1910.

Swent: Very soon after that.

Johnson: Very soon afterwards. That's why I've always felt that it was the first Boy Scout troop in South Dakota.

Swent: Was Reverend Montgomery from England?

Johnson: I sort of felt that he was from some other part, not the United States. He had come from England as an Episcopal minister, representing the Episcopal church, I suppose.

Surveying for Mt. Rushmore

Swent: So, speaking of Borglum--you were living pretty close to Mount Rushmore when it was getting started.

Johnson: Yes, I can tell you a few things about it. I remember when President Coolidge came there to dedicate the monument, I was at that time engineer for the Keystone Consolidated Mines. So I was the only engineer in the area, so Borglum asked the manager if they could have me do the survey work, to survey a road up to the plateau where the dedication was to take place. I got the job of seeing that there was a road built up there. We had to hire a man with a slip and a couple of horses, and we just excavated a road out of the hillside there to get up to the monument so that they could drive a car there. I remember we were in the middle of that and hadn't quite finished it when the presidential party

arrived. They couldn't make it with their car, so we took the horses away from the slip and tied them to the automobile, and with the horses and the power of the automobile, we made the grade. I remember two distinct--they weren't civil service, but what is it?

Mrs. J.: Secret Service.

Johnson: Secret Servicemen, one on each side, on the runningboard, standing up while we were pulling that up. The President, with a couple of other individuals, was in the car, and we got him up there safe and sound.

Swent: And this was before they had actually begun the monument?

Johnson: Oh, yes, this was dedicating the ground that the monument would be on. So that goes back to the year one on that.

All we had to work with was a slip--that's just a unit that you can have a couple of horses pull it, and it slides through and picks up the dirt and gouges it out. We took the two horses and tied them with their harness to the car axle and pulled him up.

Swent: What kind of car was it?

Johnson: I don't remember. I remember it seemed to me it looked like a Maxwell. That's an old-time car, as I remember. Wasn't the Maxwell quite old, Willmeta?

Mrs. J.: Oh, yes.

Johnson: That's what I remember. It looked like a Maxwell to me.

Mrs. J.: [to Mr. Johnson] You also put in the power line up to Rushmore.

Johnson: Oh, yes. Then I was involved in getting power up to Rushmore. We had a deal with Rushmore Memorial to get a power line and tie it to our power at Keystone. So I was involved in making a survey of the line from Keystone to Mount Rushmore to their compressor house and surveyed the line where the poles were to be. Then they brought in electrical workers to put the line in and so on, but I surveyed the line and marked where the poles were to be set.

At the same time, I had been previously involved in building a power line from Keystone to the Game Lodge. We had three diesel engines in there at the time, and so there was plenty of extra power. We got a deal with the State Park group, and I was

involved in making that complete survey and setting all the poles and getting that ready for a line, too. That was about seven or eight miles long, whereas the one to Rushmore was only about, as I remember, a mile and half or so.

Swent: The Game Lodge belongs to the state of South Dakota.

Johnson: That's right, the state of South Dakota.

Swent: And it's where President Coolidge used to come and visit.

Johnson: His summer office was there.

Swent: Was that why they were putting the power there?

Johnson: Well, I think that was the main reason. They had to have some kind of power. That was very much out in the primitive areas, you know.

Swent: Did you ever meet President Coolidge?

Johnson: Oh, yes, up there on the mountain. I decided I would get as close as I could. I don't know whether I shook hands, but I just said hi to him--[chuckles]--as he went by.

Mrs. J.: Tell about Borglum and the power line, too.

Johnson: Oh, yes. Borglum had made a flying trip on a small airplane with the state historian, Doane Robinson, over the area between Keystone and the Game Lodge and through that vicinity, to see what the country looked like. He saw this power line in there, gouged where they had cut the forest out to make a place to put the power line, and it infuriated him. He came up to the office, and he wanted to talk to the man that was responsible for cutting that line through there.

So I happened to be in the office at the time, and I said, "Well, I did all the engineering work, and I was in charge of getting a line through there, so, naturally, I'm the one to blame, then, if there's anything wrong."

"Well," he says, "that's really something that should never have been done."

I said, "You know, you can't build a power line and have it all a bunch of circles and round corners. It has to be straight."

"Well," he says, "you know, there's one thing I can tell you, boy. Nature abhors a straight line." [laughter]

I remember that very well.

Swent: He wanted the electricity up there, though.

Holy Terror Mine

Swent: We wanted to mention some of these other mines.

Johnson: Yes. Well, I might go back to the Holy Terror. I was involved in unwatering that mine and getting a mill built there and designed the cyanide plant for it.

Swent: This was an old mine that had flooded?

Johnson: Yes, it was a mine that hadn't flooded--well, it did in the true sense of the word. There were three men killed down there on the lower levels, the level below the thousand-foot, due to gas coming from an overheated compressor. It pumped carbon monoxide down there, and three men died as a result of that. Then the families sued the company for the deaths of these three men, and as a result they were suing for such a sum that the company couldn't pay it, so they shut down. That was in 1903. The accident occurred in 1901, so it took them a couple of years to try to resolve the problem. But they were never able to do it, so they closed the mine.

The mine was closed until about 1906 when the people that had bought it on the sale as a result of the suit tried to come in. They tried to unwater it in 1906. It was part of the Morgan estate from New York that was trying to unwater it. They couldn't unwater it, so they dropped the idea.

There was nothing done with the mine from that time on until 1938, when I unwatered the mine and put the electric pump at the 500-foot level. During that period, we had to pump over a thousand gallon a minute in order to unwater it to the five hundred. Finally, after years of pumping, a couple of years, why, the amount of water was down to about 350 gallon a minute instead of a thousand gallon a minute that we had to unwater.

Swent: What did you do with the water?

Johnson: We pumped it into Battle Creek, and as a result of that we ran into some problems with the Fish and Game Department. Somebody had found a dead fish out in Battle Creek, and so they blamed it on the tailings coming from the cyanide plant. The Fish and Game Department came in and investigated and said we would have to shut down if this was poisoning the water. So we hired a Dr. Karsten from the School of Mines to come up there and sample the tailings and the water and everything and make a report as to whether the cyanide was the actual unit that was causing the dead fish. Well, after analyzing the whole thing, they found out that after cyanide leaves the plant and it doesn't have its protective alkalinity, which has been destroyed, that it has no poisonous effects. So within a hundred feet of the mill, the water was nonpoisonous. We proved that definitely, so the Fish and Game Department allowed us to put the tailings in the creek from then on again.

Swent: So you were using the water from the mines for your mill.

Johnson: That's right. We ran the mill on water that came from the mine.

Later on, in this story of the Holy Terror there, it was operated for a while by the Holy Terror Mining Company. They closed down as a result of that order 208, which closed all the gold mines. At the time of the boom in lithium ores and the need for it, the Holy Terror Mining Company was instrumental in getting me to design a cyanide plant there which replaced the one that was burned down in 1930. You see, I had already had one cyanide plant there that had burned down, so I designed the plant there in 1938. We were operating that when the Holy Terror was compelled to close.

After the closing, the people that were interested in the Holy Terror, stockwise, decided they could do something about producing lithium concentrates, so they found a market through this Lithium Corporation of America. I was asked then to revamp or redesign that whole interior. We pulled out a lot of the equipment and put in flotation equipment and dryers and facilities to produce a lithium concentrate instead of a gold concentrate, you see.

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Swent: So you were using the same plant and same principles but a different product.

Johnson: Yes. Well, a different system. In a sense, we used flotation instead of direct cyanidation.

Swent: And this was, then, after the Second World War.

Johnson: Yes, this was during the period right after the Second World War. We made this concentrate, but the deal was underfinanced, so they closed the plant at the time. It was idle there until this other company that was known as Uranium and Allied Minerals came into the area. They were operating several mines, producing lithium from the mineral spodumene. Then they had a couple of other mines. They were just hand sorting them. Then they decided that they could lease that property, and they asked me then to go ahead and get it going again. We put in water softeners in the mill to soften two hundred gallon a minute water, because due to the oxidation and the uses of the mine during the period that it was operating--there was a gold mine there 1938 to '42--we couldn't use the water as it was. So we put in equipment there to soften two hundred gallon a minute, because that was the amount of water we needed to run the plant. When we did that, why, then we made a beautiful concentrate. It was then shipped to this plant there. [to Mrs. Johnson] What was the name of that company in Hill City?

Mrs. J.: Lithium Corporation.

Johnson: Lithium Corporation of America. They moved their plant from Keystone to Minneapolis, and all the ores were shipped to Minneapolis. Then, later, they moved their plant to King's Mountain down in North Carolina. So, as a result of that moving of the plant in Keystone, they shut down everything at Keystone. They were going to get all their ore from their spodumene deposits in North Carolina at King's Mountain. They lost their market. As a result, we closed the mine down, and no further lithium production came out of that mill from that time on.

Swent: It's closed now?

Johnson: It's closed now, yes.

Key Chemical Company: Lithium and Beryllium

Johnson: Then, later on, I was involved with another company that was producing lithium products, was the Key Chemical Company. We built a plant over between Hill City and--

Mrs. J.: Oreville.

Johnson: --and Oreville. We were using that to produce lithium concentrates from some mines in the Custer area. Ore was

transferred there, and then we operated that facility to produce a concentrate which was shipped to the Lithium Corporation of America, too.

Afterwards, we modified that plant and converted it over to producing another material which became of interest during that period, known as beryllium. We built a plant to produce beryllium fluoride. They had a plant near Cleveland that was converting beryllium ores there, and so we were going to ship this product of beryllium fluoride there, and they would convert it into an oxide and then into the metal. The metal became of interest as a result of the need for beryllium for the atomic bomb. It became the moderator for the atomic bomb production program instead of heavy water. They were getting the heavy water in from the fjords of Norway until the Germans took it over. Then there was a problem of getting enough heavy water, so there had been enough experimental work done to find out that beryllium metal was a moderator and would slow the atomic energy to a point where it would coalesce with the uranium product and form an explosion. That is part of the history of that particular area.

Swent: Were you aware of this at the time that you were mining it?

Johnson: No, it was sort of a secret deal. All we knew was that the demand was great. They had to have it, and the Production Board even made special trips out there to get the people interested in building the facility.

Swent: Did they get help from the Reconstruction Finance Corporation?

Johnson: Yes, that was another one. They got help from the Reconstruction Corporation but not as much as they got at Tinton. At Tinton they got money enough to build a complete mill up there. But here they just got a certain amount to help them in their financing.

Mineral Mills Incorporated; Old Mike Mine

Swent: Were you ever involved in the financing at all?

Johnson: Well, I was involved in financing the company known as Mineral Mills Incorporated, which had the Old Mike Mine and which was producing mica and beryllium. There was this Albert Gushurst up here, and I and a couple of other individuals did most of the financing on that. Of course, we all got our money back when we sold the plant to this group that owns it now, 3M [Minnesota

Mining and Manufacturing]. The 3M Corporation owns that mine now. So we sold the plant to them, and they were making a special mica product through one of their facilities back on the East Coast. They needed a source of ground mica and scrap mica, so they came into the country and were looking for it. I knew the man that was checking it out. I discussed it with him, so we made a deal to sell the mine to the 3M. They still own the mine. They made this special product. The company that was making it was called the Samica Corporation. They were able to make a product that they could take small flakes of mica and bind them together with a binding material that had the characteristics necessary to make the product almost the same as though it was natural mica. So by taking these smaller pieces, they could put them all together and make a sheet any size you wanted. So that's what Minnesota Mining was interested in with the Samica Corporation.

Swent: Do they still operate it?

Johnson: The company's still operating.

And then, another thing about 3M, they came into Keystone and helped on converting the Holy Terror mill into a facility to produce beryl. It wasn't the company itself, but it was the man who was head of the board of directors there, known as McKnight. He financed the building--the remodeling--of the Holy Terror mill. I did all the actual designing again and converted it over into a beryllium process, producing beryllium concentrates. McKnight was the one that was financing a lady by the name of Peggy Keenan to do all this work. They operated this facility there for quite a while, shipping beryllium concentrates from Keystone back East to a beryllium corporation there.

Swent: And he was on the board of 3M.

Johnson: He was on the board of 3M. He was president of it. They have a street there in White Bear Lake known as McKnight Street or McKnight Avenue or something.

Swent: When you sold to 3M, were you negotiating with them on the sale?

Johnson: Oh, yes, I was working with the group, getting them interested, and finally made the deal, and sold the property, and got our money out of it.

Swent: What made you decide to sell it?

Johnson: Well, the mine itself originally was a mica producer. It had a good record of mica production. During World War II, we took mica from that property, and sheeted it, and took the sheets.

They were made into whatever sizes we could get out of a book of mica. So when that program more or less started to drop away, why, we decided we would try and get a sale for it. Particularly, this one man, Gushurst--he just wanted to get out and get his money out of it, so we decided we would sell it.

Swent: How did you happen to find 3M as a buyer?

Johnson: Well, I knew this man that was there. Jack Brown was, you might say, the leading geologist. He was there. I had met him before on another occasion, and we became quite well acquainted with each other. He was the one that came out here to look it over, and as a result, I was able to convince him that they should buy the mica mine and have available all that reserve of mica, which they did then.

Swent: How had you met him? Do you remember?

Johnson: I don't remember for sure. I'll have to think back specifically. [pause] I think he came out here to look over--now I remember. He came out here to look over some properties that people were trying to sell to 3M. He was doing the geological work on it, and I got acquainted with him because he came over to see me about this particular property and the possible resources that were available there. He came over to see me.

Southern Mines Incorporated: Lithium Mines

Swent: What about the Southern Mines Incorporated?

Johnson: Southern Mines Incorporated was originally set up to mine lithium ores. There was a group in Rapid City that was instrumental in getting some action in that way. They organized this Southern Mines and acquired several properties in the Black Hills. They asked me to supervise their operations until they got pretty well along. They finally leased several mines but never were able to make much progress because of their lack of financing. They didn't have too much money behind them. There was a man who was an attorney in Rapid known as Farrar, and then there was another man that was working with him. Two or three together, they had organized this Southern Mines. They were in the business of producing lithium, and they had, at one time, leased the Holy Terror facility that had been previously operated for lithium concentrate, and operated it for a short time. There, again, they fell by the wayside because of a lack of proper financing.

Swent: Not lack of ore.

Johnson: No, there was ore available in the area. They were operating one mine over there south of Keystone about five, six miles--I think it may be six or seven miles. They had another property in the same area. They were all mica producers and also producing lithium mineral in small quantities. There was also some beryl being produced, so they were trying to produce three products, hand sorted. All of it was hand sorted until they made a deal for the mill, and then they tried to make a separation of the various minerals in the mill. But that financing problem kind of killed that.

Swent: "Southern," I guess, meant Southern Black Hills?

Johnson: Southern Mines Incorporated.

Swent: That would mean Southern Black Hills?

Johnson: Yes, it took place in the Southern Hills.

Swent: I keep running into Empire Mines and Empire Company. Why did they choose the name "Empire," I wonder?

Johnson: Well, I can tell you a story about it. The man who came out here originally after the price of gold went up to thirty-five dollars an ounce--this man had been working in a gold mine in California. Somebody got him interested in coming out here, and he looked the mining area over. This man interested him in the Golden Slipper Mine, and so they asked me, as the only engineer available in the area, to go up and examine it and make some suggestions, which I did. I said, "You're going to have to unwater the mine, and you're going to have to refurbish the shaft and build a headframe." So they had me design the headframe, and build it, and refurbish the shaft. It hadn't been in use since about 1910 or '11, so it was in pretty bad shape.

Swent: It was built of wood, I suppose.

Johnson: Yes, the shaft was all timbered. That, of course, had rotted and caved, and I remember when I was doing the work of setting up a headframe and getting a hoisting cable in there that I had to go down to the bottom level there that was still more or less intact and allow a shot to be taken down there with a transit so we could determine where the shaft was, so that when we hit it, we would hit it at the right angle where it would be usable. I remember looking up into the caved area, and I thought, "What am I doing down here?"

Swent: That would be pretty dangerous.

Johnson: It was. I went down on some, what we call, "hanging rods." All the timbers are hung on steel rods. So I got the shaft timbered, and then we put in a pump down at the first level, which was 130 feet down, and unwatered that level, and then went down another 100 feet. We finally got it going and sampled it, and this man--his name was Johnson--there are a lot of them in the world, I guess--he had worked at a mine called the Empire Mine in California. So he said that this appealed to him as being another Empire Mine, so he called it the Empire Mining Company.

Swent: The mine was the Golden Slipper.

Johnson: Golden Slipper was the name of the mine, but the company was organized as the Empire Gold Mines. That was due to the fact that he had worked in this mine known as the Empire Mine in California.

Swent: His name was Johnson also?

Johnson: Johnson, H. Alex. [chuckles] H. Alex Johnson.

Swent: Well, you kept the Golden Slipper for a long time.

Johnson: That's right.

Swent: You were an owner of it, weren't you?

Johnson: I am a quarter owner as it is now.

Swent: It's still going?

Johnson: And we've got it leased to a company known as Boulder Gold in Denver. One of their engineers was out the other day. They're going to do some work on it this fall.

Swent: It's operating now, then?

Johnson: No, it isn't operating at present. They're going to get it into operation. So the mine is still alive.

Swent: It's still an underground mine.

Johnson: It's still an underground mine, and the same is true with the Juniper. The same company has the lease on the Juniper Mine.

Swent: Is there any thought of turning some of these into open pit mining?

Johnson: You can't, because the vein system is different. It isn't flat, and you have to go down too deep, and you wouldn't be able to do it.

Swent: So they're still basically using the same old methods.

Johnson: That's right. Sink a shaft, and drive drifts, and stopes.

Swent: What kind of hoisting equipment did you use?

Johnson: We originally used steam. We had a steam boiler and then used steam. Then the Black Hills Power & Light Company brought their power over there, and we put in electrical hoists.

Swent: What brand of machinery?

Johnson: Oh, let's see. What's the name of that? Longyear, that was it.

Finding Lost Veins

Mrs. J.: I think you should tell about how they lost the vein, too.

Johnson: Oh, yes. When they were mining the Golden Slipper Mine after they had been operating for some time, the vein pinched out. It disappeared, and so they couldn't figure out what happened. Dr. Lincoln of the School of Mines had been their engineer. I was working at Tinton at the time on their operation, so they got Dr. Lincoln as their consulting engineer. Lincoln told them they better get me to do their work, because he was tied up in teaching. So I got the job of trying to find out why the ore body had faded out or to work out if there was any more ore left. I spent several weeks doing geological work on it, and then I finally just decided what had happened, it had faulted. I worked out where the fault was, and I tried to convince the operators about it.

They had a foreman down there that was not amenable to being told about anything, and he said he followed directions before from some of these geologists. He said, "I'm not in favor of it because I don't think it's there. It's not in that direction in the first place." So this fellow, Uppercue, who was operating the mine at the time, told me what his foreman had told him. They wouldn't do the work of running a drift over there, because of the fact that the foreman was against it. They had already spent $50,000 drifting in the opposite direction.

So I met Mr. Uppercue in Rapid [City] one day, and it was a couple of months later. I said, "Well, how're you doing?"

"Well," he said, "we're not getting very much ore. We don't have much ore left. Maybe we'll have to close down."

I said, "Did you ever go look for that ore that had faulted?"

"No," he said, "because you remember our problem."

I said, "As long as you're getting that close to the end, why don't you do it?"

He said, "I'm going right up now, and we'll do that tunnel work."

He went up there, and, oh, about a week later, why, we had a knock at our door about midnight. It was Uppercue, and he said, "I'd like to show you something." So he showed me this gold specimen that had come from this area that they had hit the ore body again. They produced over a hundred thousand dollars just from that one stope. [chuckles] And yet this one fellow--he wouldn't even consider it.

Swent: That must have been exciting to be proved right.

Johnson: I said, "Well, all you can do is, you can prove that I'm wrong, or you're going to hit something."

Swent: And you were right.

Johnson: Yes, Uppercue was sure excited. When he came in, he said, "What do you think of this?"

I said, "That looks very nice; where did you get it?"

"You told us where the gold would be, and it was there."

Swent: Isn't that exciting!

Johnson: It sure was.

I had another instance of opening up a faulted vein. After we had unwatered the Holy Terror Mine in '38, and they had rebuilt the mill--you know I designed that plant that had been burned down before. We got the operation down to the 500-foot level, and they started to open up a stope down there on what was known as the Keystone Vein. They got down there and got the

timbering in for the stope--everything lined up--and then they found out that the ore body had pinched out. There wasn't any ore there. So they called Dr. Lincoln up at the School of Mines, who had been doing their work while I was up in Tinton working, and Lincoln told them, well, the ore body had just ended.

So this Flavin, who was the manager for the people back in Maryland who had financed it, called me up at Tinton. He said, "Dr. Lincoln tells me that the ore body has pinched out."

And I said, "Well, that can't be possible, because I know that those ore bodies go down a lot deeper than that. This is only the 500-foot level."

"Well," he says, "you'd better come down here."

I said, "Well, I'll try. I'm right in the middle of something." I was doing some test work then on working out a process for their ore there, so I said, "Well, I'll take a couple of days." I went down there and looked it over, and I said, "Well, I can't tell you offhand right now. I'll have to spend some time at this. I'll have to spend maybe three or four days, maybe a week, doing the geological work down here."

He said to go ahead and do it, and so I did. I found out that the ore body had faulted off to the west about twenty-five feet, and that's the reason they weren't getting any ore. I told him to put in a raise at an angle into the ore body where it should be, and they could then use that same ore chute as an incline to get that ore down to that level where we were working. So they did.

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They got a crew working on it, driving an incline raise up to it. In twenty-five feet, they hit the ore body, and they mined it all the way through from the five-hundred to the surface. The Keystone Mine hadn't been mined before. This was as a result of the work of unwatering the Holy Terror Mine, you know. We opened up another stope down there and carried it on. They were in production until the L-208 closed them again.

Swent: What was the name of this mine?

Johnson: The Keystone Mine. That's the mine that we built the new cyanide plant on. I did the test work to decide whether there were any problems or not. We found out it did a very good job, and so they were able to mill that ore until the government closed all the mines. So there was a second instance of faulting and

fracturing. They will come up in areas like in the Black Hills where you had all this intrusive action and shifting and so on.

Swent: And finding the vein again is pretty important.

Johnson: It was, absolutely. [chuckles] Here they spent all that money in building a mill completely. You see, the other mill had been burned down to the ground. They had no equipment. They had no building. They had nothing. So they had quite an investment that they had to protect. That would have meant, really, a disaster.

Swent: They did get their investment back, though.

Johnson: Oh, you bet.

Swent: It never opened again after the war?

Johnson: No. It's being considered by several, but they've got a problem. During a time that Peggy Keenan operated in the area, why, she put all her tailings down in there as a place to put tailings, because the Fish and Game Department wouldn't let them put it into Battle Creek. So the shaft and the workings were filled up with tailings, and the Keystone Mine was filled up with tailings. So they have, now, a problem--how to get rid of the tailings and get the water so that it's amenable to being such that they could put it in the creek, you know.

So there are a lot of interesting things that happen now and then.

B&M Corporation: Drilling for Water

Swent: Yes, indeed. What about the B&M Corporation?

Johnson: That was named after beryllium and mica. They operated the Juniper property, and they built a mill there on the property to treat the ores that they were able to mill from the gold mine. Then when the gold mining situation developed again with the government order 208, why, they had to shut down, too. No, it wasn't that way. They had to close it down as a result of that air base being built and the people getting ten dollars an hour instead of five, so everybody quit. So that was the end of B&M.

Mrs. J.: They had a deep well there.

Johnson: Yes. We drilled a well there to get water for the mill first.

Swent: Couldn't get mine water there?

Johnson: Well, there wasn't enough available, so I had them drill a well that would go down three hundred feet. I can tell you a story about that, too. [chuckles]

When I was asked to determine where they were going to get their water, I made a geological study of the area and came up with the conclusion that we could get water not too far away from the mill by drilling a drill hole down there about three hundred feet. So I had the company make a deal with a drilling outfit to drill a well to three hundred feet. That was right on top of the mountain up there, and everybody said that somebody must be crazy to expect to get water up here on the top of the mountain.

So when the drillers were told of this, they just came to me, and they said, "Well, we don't want to waste any of your money. Maybe we had better just shut this down and forget it."

I said, "Why, no, we've got an agreement. You signed the contract to drill three hundred feet." Three hundred twenty-five feet it was, actually. "You're going to have to live up to your agreements. We'll pay you your money all right."

Well, they hemmed and hawed and said, "Well, it's your money you're wasting anyhow, so it won't make any difference."

They continued drilling, and I remember one morning I came there. We had been drilling for about a couple or three weeks already and were down almost to the 250-foot level. They were getting happy, because they thought they would get out of that contract and not have to waste anybody's money. About an hour after that, I left. I came home to eat some breakfast then, because I usually left early in the morning and then came back for breakfast. They had hit the water course, and the water came within eighty-five feet of the surface. The man came down to see me and said he wanted me to come up and see what they had. So I went up there, and here they had a lot of water. We pumped fifty gallon a minute out of there without a break.

Swent: For the mill.

Johnson: For the mill. And then they had a man from the U.S. Geological Survey was up there, and the workers talked with him about it. He said, well, he thought it was a foolhardy move to drill that well. [chuckles] That was interesting, at least.

Swent: What made you so sure that there was water there?

Johnson: Well, I did a geological study of the area, and I figured out where all the fractures were. The water would come down these fractures, so we had no problem. We hit it at about 280 feet instead of 325, so that was pretty close.

More About the Mine Inspector's Job

Swent: Would you like to tell any more about your job as mine inspector?

Johnson: Well, that was sort of an interesting job from more than one standpoint. Of course, I had to examine the Homestake operations twice a year and make a report on that as to whether every safety precaution was being carried on. Then I had to check all the other operations in the area, too, if there were any. Then, back in the eastern part of the state, I checked all the quarries and checked all of the gravel deposits because that was the main operation in the way of mining in those days. They were building highways and roads and using a lot of gravel, so it was interesting from that standpoint.

Swent: Were any of the mine operators ever not cooperative with you?

Johnson: There was one instance I remember, going over to one quarry. I told them that they better slope the bank or they're going to have trouble someday. I said, "I'd like to see it done before I get back next month." They didn't do it right away, and there was a man badly injured. The face of it slipped. It was almost fifty feet high, this bank was, and there was a fracture that resulted sort of where it could cave off. The whole thing caved down, and he got pretty badly hurt. That was the only instance that I know of.

Swent: Did you have any power? What could you do to enforce--?

Johnson: Why, I could shut them down.

Swent: Immediately?

Johnson: I gave them a month. You give them a certain period of time, and then you follow through on it.

Swent: And this was by state statute, was it? You were controlled by state laws.

Johnson: Right. That's right.

Swent: What was your relationship with the BOM [U.S. Bureau of Mines]?

Johnson: I didn't have any in those days.

Swent: This was late sixties.

Johnson: No, there wasn't any relationship with the BOLM--Bureau of Land Management.

Swent: Oh, I was thinking of Bureau of Mines--the national Bureau of Mines.

Johnson: Oh, the national Bureau of Mines. We naturally corresponded. We sent them a copy of our annual report.

Swent: But at that time, there were no federal statutes that you had to worry about?

Mrs. J.: At the time that he would introduce himself, they would say, "Well, we've never seen a mine inspector before."

Johnson: Yes.

Swent: There had been inspectors before, but they weren't on the job?

Johnson: Well, they were way back in Washington, D.C.

Mrs. J.: No, they were here.

Johnson: Yes, but most of them only came here occasionally.

Mrs. J.: No, the state mine inspectors. There were others ahead of you.

Swent: You were not the first state mine inspector.

Johnson: Oh, no. We had had state mine inspectors in South Dakota since about 1890.

Swent: But some of them hadn't been very vigorous?

Johnson: Right.

Swent: Why, I wonder?

Johnson: Well, they're a department in itself. You're only responsible to the governor. You don't have any other connection to report to.

Swent: What about the situation in a state like this where there's really only one big mining company? What difference did this make in your work as mine inspector?

Johnson: Well, not too much, because we had the bentonite deposits in western South Dakota. We had the quarries in the eastern part of the state, and we had gravel deposits all over the state.

Swent: I wondered whether the rules were sort of set up for Homestake.

Johnson: No, I think they've amended a lot of rules since it was organized. Right now there is a lot of difference in the approach to the problem. You've got this committee over in Pierre that determines whether you're going to even work it.

Swent: What committee is this?

Johnson: Well, what do they call it? The Bureau of Land Management or something like that. For instance, you've got to get a permit to mine. That permit is examined as to whether it's feasible.

Swent: Is it EPA? Is that what you're thinking of? Is that the environmental people?

Mrs. J.: Mineral resources.

Johnson: Mineral resources.

Swent: And they decide whether or not you can get your permit.

Johnson: That's right.

Mrs. J.: And the Forest Service is a lot more strict now, too.

Johnson: They are a lot more strict than they were then.

Swent: The Forest Service.

Johnson: Yes, the Forest Service. They have to okay the permit, too, because if it's on Forest Service land, they can stall it off so you can't even get a permit.

Swent: Have you ever had any dealings as an operator with unions?

Johnson: Well, not particularly, no.

Swent: When you were mine inspector, did you have any dealings with the union?

Johnson: No, I really didn't. But the union finally wanted to control the appointment of the mine inspector. For instance, at the time my

term ended there, the union advised the governor as to who to appoint.

Swent: That would have been the steelworkers union?

Johnson: Whatever union was in Lead. I think that is the steelworkers.

Swent: They wanted to appoint the mine inspector.

Johnson: That's right.

Swent: So, what happened?

Johnson: They appointed this one fellow that was a miner. He had never had any technical experience of any kind except he had worked in a mine. So I don't think it was very solid, but they wanted to control it there in Lead, so they had the governor appoint a man who was just, you might say, a regular mine worker. He had been doing drilling and so on, and blasting.

Swent: He was the one who succeeded you, then?

Johnson: Yes. The Democrats were convinced by the union that they had to appoint a union man.

Swent: You don't think it did so well?

Johnson: Well, it didn't work out too well. As a result, why, the state finally eliminated the mine inspector's department, so it doesn't exist anymore.

Swent: The federal government, then, has come in to do a lot of this, haven't they?

Johnson: That's right. There's a federal mine inspection department that comes in and checks.

Swent: MSHA [Mine Safety and Health Administration], I guess it is?

Johnson: Yes, that's right.

Swent: And that didn't exist when you were mine inspector?

Johnson: No.

Swent: So you were just simply operating under--who set your rules? Was it from the state legislature?

Johnson: Well, there was a book of rules that had been developed during the years of mine operations and so on. That was being used as the state manual.

Swent: Were the mines, in general, fairly safe, did you think?

Johnson: Yes, I think most of them were.

Swent: Sometimes those rules are awfully hard on a little individual mine.

Johnson: They have to do some things that miners sometimes don't think is necessary.

Swent: It can be very costly, too.

Johnson: That's right, and that's one reason why they don't want to do it.

Mrs. J.: Hard hats.

Swent: They didn't like hard hats?

Johnson: What?

Mrs. J.: A lot of them didn't like the hard hats.

Johnson: Well, that's true, but they had to wear them, because, you know, you can't work in an underground operation with the possibility of a rock falling on your head.

Swent: Yes. A lot of them didn't like it, though.

Johnson: I know, because they're uncomfortable.

Mrs. J.: Yes, I remember in those gravel quarries, they didn't think it was necessary, and that was one of the rules.

Johnson: Yes.

Swent: What about the respiratory equipment?

Johnson: Well, the only time they used any of that was during mining, in case a mine was filled with gas. You had to have a special group, you know, to go down there, that had been trained in the use of that kind of equipment.

Swent: Didn't they need masks in the quarries for dust?

Johnson: No.

Swent: Not in those days. [looking outside] We're having a hailstorm.

Johnson: Is that what that is?

Swent: I think it's hail.

Johnson: Had to come to Lead to get the hail, didn't you?

Swent: Yes. Let's see what else we have here. Is there anything more you would like to say about the mine inspector job?

Johnson: No, I think that covers it pretty well.

Swent: Did it pay well enough that it would it attract somebody to the job?

Johnson: No, it was not too high a pay, but it was a different program, so that's what interested me. They should pay about twice what they were paying.

Swent: That's often one of the problems. It's hard to get somebody.

Johnson: That's right. I tell you, the various meetings of the mine safety Program in the United States--they had an annual meeting. Mine inspectors from all parts of the United States would attend the meeting, you know, and then would discuss problems of safety, et cetera.

Swent: Did you enjoy those?

Johnson: Yes. We went to--[to Willmeta]--was it a couple of them? The one down at Louisville?

Mrs. J.: Yes.

Johnson: I can't even remember where they were.

Swent: So you were an inspector for four years, weren't you?

Johnson: Right.

Swent: That would be two terms?

Johnson: Yes.

Mrs. J.: Two terms and part of--yes.

Johnson: Part of another, yes.

Mrs. J.: Most of the mine inspectors came from coal mining districts.

Johnson: They were principally coal miners.

Swent: If there was an accident, you were called in, then.

Johnson: That's right. We had to establish the reason for the accident and what hadn't been done right, or so on, and make a report on it.

Swent: Was this quarry accident that you mentioned the worst one that you had to do?

Johnson: There was an accident at Homestake Mine that happened there, but it was definitely an individual's own responsibility. I think he fell into one of those raises. He should have known more than that, you know. So it was one of those things where nothing could have been done to alleviate it, except the individual had to be trained to be working safely somewhere.

Swent: That's the whole problem, isn't it?

Johnson: That's right.

Swent: Motivating them.

Johnson: Motivating them to realize that they are responsible for their own action.

Well, I think I've covered everything pretty thoroughly there.

Swent: Well, those were all the questions I had.

Johnson: Well, I brought in these several companies which we have discussed and have got that all in there. I don't know of anything further.

Swent: You've had a remarkably long career.

Johnson: [chuckles] I feel that I've at least had an opportunity to see the world from that angle.

Mrs. J.: [to Mrs. Swent] Did you want to ask him about tungsten?

Swent: Oh, yes. Was there any more you wanted to say about tungsten?

Johnson: I got interested in tungsten way back when I was a junior in high school. Dove was the head of the chemistry department in Lead High School here. He had set up a laboratory, and that was during the heyday of the tungsten boom. Homestake had a mill down here on Gold Run Gulch area. They operated several mines

for tungsten. There was a mine going on at Yellow Creek that was producing tungsten, and so this Dove had set up a laboratory in his chemistry department to check samples of tungsten ore, or ores that people thought had tungsten in them, and make a report. Then, also, normally, the ore that has tungsten has gold. So he set up a fire assay department. I worked, as I said, over at the Amicus Mill, so I was knowledgeable about treating all gold ores. As I found out that he was setting this up, I asked him if he wouldn't let me work with him.

Swent: This was outside of school hours?

Johnson: Yes, outside of school. It was while I was a junior in high school. I told him, "I don't expect any pay. I'm just interested in learning something." So I had a chance to learn how to analyze for tungsten, and I learned how to operate a fire assay furnace while I was still in high school.

Swent: And he was doing this outside of school, also?

Johnson: Right. Yes, it was done after school and on Saturdays. And if it overlapped Sunday, we did it Sunday. I got interested in it at that time, and then in the Hill City area there was a mill operating for tungsten. In fact, there were two mills in the Hill City area, so I had occasion to check in with them once in a while just to see what was going on. There wasn't too much activity in tungsten in the Southern Hills. There was, oh, I would say, a lot of different deposits that were very minimal in their possibilities of production, but up in the Northern Hills here they had a large number of possibilities. They had one up in the Trojan area, and they had one over here north of the open cut in Lead. They had this Yellow Creek property that produced tungsten, the flat formations. Several places had certain amounts of it, so I was just interested in a general way with the mechanics of treating the ore and perhaps trying to find a tungsten mine. But they're few and far between.

Swent: Did you ever find one?

Johnson: No, but I did investigate a lot.

Swent: Did this come in handy later--this experience?

Johnson: Oh, yes. Sure, absolutely. It gives you a basis for interpreting what you see.

Swent: What was tungsten used for?

Johnson: It was used in alloys. Tungsten carbide was a high density combination that was very hard. It was used in cutting steels, so tungsten was of interest particularly for that purpose for cutting tools.

Swent: Filaments?

Johnson: And, of course, electrical filaments. But they found other elements that were a little bit more satisfactory, I think.

Swent: There was another thing I wanted to ask you about. What about drilling equipment? What sort of drills have you had acquaintance with? Has there been a change in them through the years?

Johnson: Well, yes. Of course, back in the good old days, when they were first mining in the Black Hills here, they had these cumbersome drills. Stopers were not known. They had these tunnel drifters, and they would set them on a steel post, and then they could move the unit around the post. Also, they would do a lot of work with hand-operated mechanical drills--air drills. They've improved that a lot from the standpoint of the fact that they use better materials in them. They're a lot lighter in weight. They'll stand up longer. As a result, why, the whole operation is simplified.

Swent: What about these small mines, though, when we're talking about these little individual mines--are they able to use the drilling equipment?

Johnson: Oh, yes. They have a compressor and usually hand drills that they use. Most of them don't do underground work in such a way that they need a drill on a drifter or a stoper. It's mostly hand drills and hand-handled.

Swent: You've seen a lot of changes.

Johnson: Oh, I should say. I remember the first drills they used in the Holy Terror Mine. Why, it took two men to lift the unit to set it up. Now, one man can do the whole job himself.

Swent: Lighter weight materials.

Johnson: That's it. And a lot better materials, you see.

Well, I can't think of anything else.

Swent: If you had it to do over, would you still be a miner?

Johnson: Why, sure. Why not? [chuckles] I could have continued in teaching, you know, but that wasn't what I was raised on, as they say.

Swent: So you stuck with it.

Johnson: So I've, as they say, held on to the bitter end.

Swent: Well, this has been very interesting. Thank you very much for telling about your career. And thank you, too, Willmeta.

Transcriber: Noreen Yamada
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TAPE GUIDE -- A.I. Johnson

APPENDIX TABLE OF CONTENTS

A Mine With More Varieties Than Heinz Has Pickles

The Ingersoll Mine, Keystone, S.D.

By A.I. Johnson, Mining & Metallurgical Engineer

A few miles from Keystone, S.D., is a pegmatite mine which, since its discovery, has been a mecca for geologists and a paradise for rock hounds. Well over sixty separate minerals have been identified at the mine and, no doubt, more will be discovered. Some are of scientific interest only but a number have commercial value and several are both rare and valuable.

The Ingersoll Mine was originally discovered and located August 24, 1880, by John W. Okey, John Schofield and R. G. Williams. According to the location certificate it was situated "on Fairview Hill, east side of Poney Gulch, one and one half miles from the town of Sitting Bull, bounded....on the South by Intersection and Independence Lodes..." It was named for Bob Ingersoll, at that time a well-known lawyer and politician noted for his agnostic views. Two other claims were located in the same group. The Horace Greeley was named for the popular editor and the Ben Butler was named for another lawyer who was a radical politician. (We don't know the political or religious views of the locators.)

The group of three mining claims was surveyed for patent in 1890 by Myron Willsie and the survey was filed April 17, 1891. The patent was issued and signed by President Grover Cleveland Dec. 4, 1894, "in the year of our Lord and of the Independence of the United States the one hundred and nineteenth." In mining language a patent is the same as a warranty deed to property. In the meantime, Harney Peak Tin Mining, Milling and Manufacturing Co. had paid $155.00 in fees for the Ingersoll Group to George V. Ayres as Receiver in the United States Land Office at Rapid City and had full title.

The discovery of tin in the Black Hills in 1883 had created great interest in its possibilities, particularly in England because Cornwall was the world's leading producer of tin, a position it had held for several hundred years, dating back to the Roman occupation. Prior to this some Black Hills tin had been identified as early as 1876 or 77. The Harney Peak Tin Mining, Milling and Manufacturing Co. was organized by a group of London and New York financiers and they undertook to monopolize the tin deposits of the Southern Hills. They were rported to have spent over ten million dollars in acquisition, exploration and development of over 1100 properties, including the Ingersoll Group. A hundred ton mill was built at the Etta Mine where there was a small town and post office named Etta, located near the present town of Keystone. At the Ingersoll a tunnel was driven 145 feet long to contact the tin deposit 120 feet below the surface but in 1889 an engineer, C.M. Vincent, engaged by English investors to make a report, stated that results were not encouraging

but inferred that possibilities might be better at greater depth. A larger tin mill had been built in Hill City but because of the poor showing the Harney Peak Co. was forced into receivership in 1893 and all the properties were in litigation for many years.

The receivership was handled by the Pahasa Mining Co. which proceeded with liquidation. On Nov. 15, 1914, the Ingersoll Group and other properties were sold to Charles E. Kamman of Hill City. He leased the Ingersoll to Denis Henault. Henault was an enterprising Frenchman who had mining interests in the Northern Hills and who had served Custer County in the state legislature.

During Henault's lease, tons of lithia ores, mica and beryl were shipped. One very large mass, approximately one ton, of columbite-tantalite, probably the largest single mass of that ore ever described at the Ingersoll, was shipped to Maywood Chemical Co. in New Jersey. Henault thought it was tin ore but when the true identification was made the shipment was discarded as there was no value for columbite-tantalite at that time. At present that tantalite content has reached from $80 to $100 per pound.

W. S. Dewing of Kalamazoo, Mich., owner of the "Kalamazoo Straight to You" Stove Co., had become interested through James "Big Hat" Clark in numerous other mining properties in the area. Dewing paid Kamman for the Ingersoll Group which was under lease to Henault and deeded one-half interest to Henault with a mortgage attached for that half interest in 1923. Dewing later, in 1930, foreclosed on the mortgage. His heirs-wife Caroline, daughter Winifred D. Wallace and her husband, William Kay Wallace of New York City, conveyed their rights to the Black Hills Keystone Corp. July 15, 1932. Eventual control of the corporation came to Wallace's second wife, Karin Wallace, who lives in Monaco.

Harold Schafer, president of Gold Seal Glass Wax Co.,bought the Ingersoll in May of 1980 and he has sold the property to U.S. Mining Co.

This property is a classic example of a coarse-grained pegmatite and has been studied by geologists from all over the world. Three principal pegmatite dikes are exposed. The mineral segregations are large enough to make possible hand sorting of the various kinds. The dikes usually consist of a quartz core with the different segregations extending outward to the walls of the dike which are most often schist or its modifications. The different minerals are separated according to their temperature gradient at the time of the formation of the dike. An intrusion of a viscous material contained all the minerals which, on cooling, became segregated from each other. For instance, we find a greissen zone, principally fine-grain mica, then coarser mica followed by a feldspar zone and, next to the core, are usually the rare minerals.

BERYL is one of the rare and valuable minerals occurring in the Ingersoll. Crystals of large dimensions always create great interest among mineralogists and geologists especially if the crystals are well-formed and free from foreign minerals or of gem variety. Beryl crystals, whether large or small, are six-sided and vary in color from white to green. The emerald is a transparent phase of beryl. Sometimes the beryl may be light shades of blue,yellow or rose.

About 1915 a large beryl crystal was exposed at the Ingersoll, a nearly perfect hexagon and white in color. It was 46 inches across the face, 44½ inches high and approximately 8 feet long. In 1933 the first large crystal was uncovered on Dike #2. It was 9 feet 8 inches high, slightly over 8 feet wide and produced 24 tons of beryl. In 1942 the second large crystal was exposed on the same dike which was 19 feet long and tapered from 5 feet in width at one end to 19 inches at the other end. Dr. Hess, head of the Rare Minerals Division of the Bureau of Mines, visited the site and wanted to make a national monument of the formation but, because of the strategic importance of beryl in the war effort, the crystal was mined and sold.

In the fall of 1944 the largest beryl crystal yet uncovered was encountered in Dike #1 and measured 28 feet long with the faces 8 feet 6 inches by 8 feet 8 inches in width. Over 64½ tons of beryl were recovered. Many smaller crystals have been mined through the years.

No specific use was known for beryl until Brush-Beryllium Co. of Cleveland, Ohio, developed a process of producing the metal beryllium from the beryl mineral. The problem of a brittle metal, easily shattered, had been overcome and a ductile metal was finally possible. The Brush-Beryllinm Co. then needed a reliable source for the mineral and the Black Hills Keystone Corp. became a major producer. A 20 ton carload from the Ingersoll and Sitting Bull mines and an additional 43 tons from the Ingersoll were shipped in 1933 and another 11 ton shipment in 1934. Between 1933 and 1956 a total of 518 tons was shipped with the main production during the WWII years.

An unusual use by the government for the metal beryllium was as a moderator in the detonation of the atomic bomb. Another interesting use was in the nose of the space capsules because of the capacity of beryllium for quick absorption of heat and rapid dissipation of heat. Previously a use was found with copper. A small percentage acted as a hardening agent to make the copper as hard as steel. This copper alloy could be formed while still malleable, then heat-treated for hardening. This was thought to be a new process. However records show that the copper product found in excavations may have been used by ancient Egyptians, then becoming a lost art. Adding less than 1% beryl to feldspar furnishes a brilliance to ceramics, important in that industry.Beryllium has the unique property of strength associated with light weight.

Several lithia minerals of economic importance have been found at the mine. It has been one of the largest producers in the United States of LEPIDOLITE which is used principally in the glass industry. About 9000 tons have been mined and milled. It occurs in masses of flakes and hexagonal crystals up to ½ inch, in lilac and purple shades desired by decorators and collectors. It gives qualities to glass which make the glass less liable to breakage on sudden heating or cooling, produces a harder surface, makes the glass less brittle so it withstands shocks and vibrations, makes it more lustrous or brilliant, eliminates much corrosion in the manufacturing process and is a good opacifier. Two interesting uses of the Ingersoll lepidolite were in the making of Pyrex ware and in a lens for the observatory at Mt. Wilson, Cal., where its use allowed the huge 17 foot lens to cool slowly without warping.

At the mine it was hand sorted for a long time but larger reserves were developed and demand increased so a mill was built and began operation in July 1942, closing in September 1944 when foreign sources made production uneconomical By-products of the lepidolite milling were mainly tin, tantalite-columbite, and microlite concentrates.

TIN, in the form of CASSITERITE, is found in lustrous black masses up to 100 pounds and smaller masses of granular structure have occurred. Some concentrates have been shipped as a by-product. ZIRCON, a sharp reddish brown crystal, has been found in the cassiterite. It fluoresces under ultraviolet radiation.

Also found with the lepidolite are gem varieties of TOURMALINE crystals. The pink tourmaline is known as RUBELLITE, the black as SCHORL, the brown as SODA DRAVITE, the greenish blue as INDICOLITE. They have specimen value.

MICROLITE, a calcium tantalate, was a by-product of the lepidolite process. Over a ton was shipped.

Occurring with lepidolite, but with unknown mineral associations, were the rare metals, CESIUM,STRONTIUM and RUBIDIUM in small quantities.

TANTALITE, a black heavy mineral, has been produced in the milling of lithia minerals. Usually it is associated with COLUMBITE which has very similar characteristics. World wide recognition has come to the Black Hills for the excellent specimens of tantalite-columbite, including those from the Ingersoll. Previously we mentioned the one tantalite mass shipped by Henault under the impression it was tin. Tantalum is used in surgical wire, sugical instruments and chemical ware, replacing platinum in many instances. It doesn't corrode, is malleable. Columbium is used with steel to add toughness. One use is in the armor plate on battleships.

An exciting find during the mining for lepidolite was URANINITE, classified as PITCHBLENDE, a source of radium. Mme Curie separated radium from a mineral of this kind. A sample by Dr. Hess of the U.S.Bureau of Mines in Wash-

ington was used to make an age determination of the Black Hills. Results indicated the age of the Black Hills to be 1,620 million years, plus or minus 20 million years! In the superb solid masses up to 5 inches in diameter and 2 inches thick there were thick yellow or red alteration rims of AUTUNITE, URANOPHANE, KASOLITE, FOURMARIERITE andVANDENDREISSCHEITE. 350 pounds was produced. Many unusual specimens were taken.

The mill at the Ingersoll for processing lepidolite and its by-products was the first and only one of its kind in the world.

The other two economic lithia minerals at the Ingersollare AMBLYGONITE, a lithia aluminum phosphate, and SPODUMENE, a lithia aluminum silicate.

The largest mass of amblygonite was exposed at the top of pegmatite Dike #I. This developed to be 28 feet long, six feet in diameter. It was a vertical projection and it was necessary to sink a shaft through the mass to mine it. It occurred on the contact with the lepidolite zone. 1500 tons were produced and most of the amblygonite was shipped to Germany, going via Chicago and the Great Lakes.

Spodumene was in demand during WWII and nearly 200 tons were produced for Maywood Chemical Co. in New Jersey. It occurs in "logs" of hexagonal shape. White crystals 10 feet long, 2 to 3 feet wide were mined.CYMATOLITE, a white fibrous material is found in the crystals. With the spodumene are semi-precious gem varieties of green to yellow-green HIDDENITE, lilac-pink and bluish KUNZITE.

The strategic value of the lithium hydride produced from the spodumene was its use in inflating balloons or flares for signalling whereabouts of ejected aviators. Water added to the lithium hydride formed hydrogen gas which inflated the balloon. Lithium hydroxide is used in batteries and also in high grade grease. Lithium carbonate is used in ceramics. There are numerous medicinal uses now made of lithia products of spodumene. One is supposedly for reducing hypertension.

The most common economic minerals found at the Ingersoll are FELDSPAR and MICA. Very high grade quality of feldspar is found and among its many uses are those for dishes, bathroom fixtures and glazes. "Accent" on your kitchen shelf,to enhance the flavor of food, comes from soda feldspar.About 15,000 tons of feldspar have been shipped.

About 2200 tons of scrap mica have been produced. It is high grade and very white and is used in Christmas snow and in wallpaper. Some is used in paints and greases. Green tourmaline was found with this mica.

A by-product of the feldspar operation was some high quality WHITE QUARTZ, mostly used for decorative purposes.

Some of the minerals in the Ingersoll Mine have been depleted but diamond drilling by the Bureau of Mines indicates a considerable variety still in place. New methods and new uses may increase the value of the reserves in the future.

A. I. Johnson was the engineer in charge from 1933 to 1980 and was responsible for the geological surveying, mining methods, mill construction and processes.

To substantiate the claim of more varieties than Heinz a list is here appended of the identified mineral occurrences in addition to those discussed in the above paper:

apatite
albite
biotite
lithiophilite
triphylite
montebrasite
purpurite
griphite
triplite
varulite
iolite
lollingite
Brazilian emerald
topaz
garnet
heterosite
pinite
chrysoberyl
muscovite
perthite
cleavlandite
oligoclase
andesine
galena
samarskite
euxenite
stannite
magnetite
limonite
manganite
pyrolusite
hematite
sericite
graphite
sheelite
molybdenite
arsenopyrite
talc
kaolin
torbornite
gummite
metatorbernite
metaautunite
staurolite
sicklerite
triphane

March 1983

Some Interesting Sidelights from the History of Mining in the Black Hills.

A. I. Johnson
South Dakota State Mine Inspector

Midwest Federation of Mineralogical and Geological Societies
Murdo, S. Dak. June 14, 1969

Gold

The first mineral production in the Black Hills dates back to the summer of 1875. The first actual production of any sizeable amounts of gold from the placers of the Black Hills is tied to the major gold rush to the Black Hills of that date. Frank Bryant is reported to have discovered gold in the Deadwood area in August of 1875 and by the spring of 1877 the gold rush had reached its peak. It is reported that some $1,500,000 in placer gold was produced during the year of 1876. The first white men to see the Black Hills were Francois and Joseph de la Verendrye of Three Rivers Canada, they reported that they arrived at Bear Butte Mountain August 11, 1742 and traveled in a southwesterly course thru the Black Hills . Meriwether Lewis and William Clark report to having met a prospector near the mouth of the Cheyenne river October 1, 1804 who reported to have found nuggets of gold in the Black Hills. There are reports of several parties having been in the Black Hills as the Gordon party which came into the hills at Custer in 1874 reported finding old sluice boxes and other indications of placer operations. Further it is reported that the Indians traded for gold in the 1860's at Fort Laramie. As a result of many rumors of gold in the Black Hills many groups attempted to enter the hills but were turned back by the army as the Black Hills was considered Indian territory. However the depression of 1873 accentuated the interest in the gold in the Black Hills and the rush reached its peak in 1875. Placer gold was reported at the time from the Custer, Hill City, Sheridan and Rockerville areas. Gold was discovered in the Rockerville area December 1876 by William Keller and over $150,000 in dust is reported to have been taken in 1877 and by the end of 1879 the total placer gold from Rockerville is reported to have passed the half million dollar mark. Ross and McKay had discovered gold in the Custer area in 1874 but Custer was passed up for the richer diggings in the Deadwood and other areas. General Custer who entered the Hills in 1874 (summer) reported traces of gold and in his passage thru the Hills climbed Harney Peak. Placer Gold in the Keystone area was reported in the early 1880's from Mitchell bar. Placer gold operations in the Tinton area in the northern Black Hills records an interesting story. After the area had been placered by the first groups into the region it is reported that a group of negroes came into the field and it is reported they took over $15,000.00 in placer gold and when they left they had to be protected by a unit of the U.S. Army. Later in the early thirties Johnny Perrit found a nugget valued at over $800.00 on Potato Creek which had previously been worked over.

After the excitement of the Gold Rush had simmered down prospectors began to look for the source of the placer gold and the hard rock miner came into the picture. The Homestake Mine was discovered in the spring of 1876 by Fred and Moses Manuel. In the summer George Hearst and J.B. Haggin sent in mining engineers and the Homestake Mining Company came into being. On July 12, 1968 the Homestake Mining Company completed 90 years of mining and milling gold ore. A total of 102,800,000 tons of ore had been processed to produced 28,150,000 ounces of gold. In addition some 1,350,000 ounces came from other properties prior to consolidation with Homestake. Others areas also came into prominence - the Trojan and BaldMountain area; the Keystone area , Home of the famous Holy Terror Mine, and many other less spectacular mines were put into production. With the interest in gold production at Lead and Trojan came many devel-

in the processing of gold ores. The first cyanide operation to produce gold was developed in the Black Hills and with it came the development of special equipment for the purpose- the Dorr agitator, the Dorr Thickener , the Dorr Classifier and the Merrill press all standared equipment in the gold milling industry.

As a result of all of the activity in gold mining the agricultural areas in and around the Black Hills were opened up and developed. The men worked in the mines during the winter months and then developed their homestead rights during the summer months. Hence the development of the western part of South Dakota, eastern Wyoming and Montana owe a great deal to the gold mining industry of the Back Hills. Today the Homestake mine still ranks as the largest gold producer in the United States, producing last year over $21,770,000 .00 in gold

Tin

Tin was first reported in the Black Hills by Richard Pearce of Denver, who identified it in the placer gold, as the mineral cassiterite, from the production from the Northern Black Hills, probably from the Tinton area. This was in the year 1876. It was later reported from Elk Gulch south of Keystone in 1877. The first tin mill to recover the mineral was built on the Etta Pegmatite area. The Etta Mill was begun in 1885 having a capacity of 100 tons per day. The second mill was built at Glendale, about two miles south of Keystone. In 1889 a larger mill was started at Hill City with a capacity of 250 tons per day and completed in 1894. This was an undertaking of the Harney Peak Tin Company financed entirely by English capital. At the time Cornwall England was the center of tin production. The new mill at Hill City is reported to have cost of $250,000.00. During this period the company acquired over 1100 mining claims, and during the period of its life had expended some $2,000,000 in its various operations. Most of the deposits were very low in grade, one lot of over 5,000 pounds reported as only averaging about one half a pound per ton in tin. As a result only a few thousand pounds of tin was produced. The company went into receivership. In clearing up some of its many reminifications, an attorney by the name of Rushmore was sent out to close up the affairs of the Pahasa Mining Company and while on one of the properties he inquired of his guide, Mr Swanzey, what the name of a certain prominent mountain was. Mr. Swanzey replied that it had no name but from then on it would be called Rushmore.

In 1902 Tin mining became active at Tinton and a small milling plant was built in Mallory Gulch and the concentrate shipped to England. This was remodeled in 1908 and expanded. It produced a total of 24 tons of tin concentrates in 1909 and 38 tons in 1910. Operations were discontinued in 1911. In 1928 a large plant was built at Tinton by the Black Hills Tin Company with capital from Chicago to process the tin-mica ores . This plant operated only a very short time. Later in 1936 and 1937 investigations were started to determine the grade and reserves of the tin ore in conjunction with the reserves of tantalite then under exploration by the Ensteel Metallurgical Corp of North Chicago, Illinois. Estimates by the U.S. Bureau of Mines and the U.S. Geological Survey indicate a total production of some 379,979 pounds of tin valued at $110,276.00. Although another attempt was made in 1915 by the Hill City Tungsten Production Co to process tin and tungsten ores in a plant between Hill City and Keystone and a Company opened up the Cowboy mine at Hill City which treated ore in the old Hill City tin mill very little additional proudcion resulted

Mica

As the wave of excitement over the discovery of gold moved on to the northern Black Hills from Custer, the miners began looking for other mineral deposits. Exploration for mica was reported as early as 1879. This work was done on the McMakin mine, later named the Crown Mica Mine, Up to July 1, 1884 it had produced 45,000 pounds of cut mica at an average price of $3.00 per pound. A little later the New Yorkmine, the Lost Bonanza and the Climax mines were opened up and the total production to July 1 1884 from these operation amounted to about 40,000 pounds of sheet mica. However the total production for the year 1884 only amounted to 18,150 pounds valued at $63,525.00. After the 1884 production most of the mines ceased operations until 1898 and 1899. when operations were again undertaken. As a result a total of 65,000 pounds of sheet mica was reported as produced in 1900 and the first scrap mica was shipped from the Black Hillls. The proce realized for the 1900 production was reported as only $45,000.00 much less than for previous out put. During the year some 222 tons of scrap mica was shipped at a value of $1,554.00. The following year some 200,000 pounds of scrapmica and sheet mica were shippe the ehtire production coming from the New York Mica mine and the Crown.

In 1906 the New York and other mica mines were taken over by the Westinghouse Electric and Manufacturing Company. This resulted in a fairly large production. During the period 1907 to 1911 the annual production of sheet mica ranged from several hundred thousand to more than a million and one half pounds of rough sheet and from 300 to 1000 tons of scrap mica. Following this there was a period of practically no activity in the mica mines until about 1943 or during thewar period. About 1942 further activity was stimulated by the demand for sheet mica. Mrs Gladys Wells set up a sheeting and rifting plant at Custer and a Company Mineral mills Inc built a rifting and sheeting plant at the Old Mike Mine north of Custer. They brought in skilled help from North Carolina to train personnel for this work and finally during the war period this company had expanded it operations until they were employing a total of about 100 women for this work in three shops situated in Custer, Hill City and Deadwood. In the mean time the government had set up a shop in Custer under the auzpices of the Colonial Mica Company and employed about 75 women in this work. As a result over 135 separate mine operations were in production three of which produced over 20,000 pounds of sheet each and one the vaictory mine produced 75,459 pounds of sheet valued at $488,255.89. Another mine produced over 40,000 pounds. With the end of World War 2 the demand for sheet mica ceased as the government held large reserves and the proce was greatly reduced. Since that time no sheet mica production has been noted. Scrap mica has been produced in the Keystone area since the war but in limited amounts, the principal production coming from the Peerless mine. It is estimated that some 53,500 tons of scrap mica have been produced to the end of 1968 since the first reported production of scrap mica in 1900.

Feldspar

High quality potash feldspar was first shipped as hand sorted material in 1923. This continued until 1929 when the Consolidated Feldspar Corporation from Spruce Pine N.C. built a grinding plant at Keystone. A second plant was built at Custer by the Schundler Company and as a result the Black Hills Production reached a peak ifn 1946 of 74,540 tons , second only to North Carolina. The plant at Custer was built in 1936 . The Abington Sanitary Manufacturing Co. starting shipping hand sorted feldspar from the White Elephant Mine in 1928 and continued until 1966. The Keystone mill wad destroyed by fire about 1957 and some time later the Custer plant also was burned. However the Custer plant was rebuilt and has a capacity of 150 tons per day at the present time. The larger producers in the Keystone area include the Hugo Mine-300,000 tons, the Big Chief Mine 75,000 tons;; in the Custer area the Nevins Mine and the Shamrock- in Pringle, the Smith and White Elephant Mines.

The tin, mica, feldspar, lithia minerals, beryl, tantalite and columbite have all been produced from the pegmatite areas of the Black Hills. In the Northern Hills, in the vicinity of Tinton, on the Wyoming-South Dakota border the pegmatite area covers a section one and one half miles in length and about one half a mile in width. Within this area some 200 separate outcrops have been counted, the major development being in the Tantalum Hill area and the Rough and Ready tin mine. The area to which the pegmatites of the Southern Black Hills are confined extends from Hill City-Keystone on the north to some distance south of Pringle, over a length of some 15 miles and lie on both sides of the Harney range.

Lithium Minerals

For many years the Black Hills Pegmatites were the only source of spodumene, a lithium aluminum silicate, which became a highly critical mineral during world war 2 for lithium hydride, used to inflate antennae carrying balloons, sent up by flyers downed either by enemy fire or otherwise. As a result of the stimulus from the war need production from the Etta mine was increased considerably. In 1936 and1937 the Black hills Tin Company had undertaken research work to recover spodumene from a very finely distributed deposit on Tantalum Hill and during 1937 shipped the first car of spodumene concentrates produced by flotation procedures. This process later became the basis for production from plants built at Hill City by the Lithium Corp of America, and the Uranium and Allied Miners Inc at Keystone. The mill at Hill City was built to process ore from the Mateen pegmatite at Hill City, the Beecher lode at Custer and the Sink and Float Plant at the Edison mine at Keystone. The plant in Keystone treated ore from the Dyke Lode south of Keystone and from the Etta dumps. Later the process was adapted to the ores of the Kings Mt. area in North Carolina and now the entire production in the United States come from flotation plants in the Kings Mt. area.

The Etta spoduemene deposit is well know from the occurrence of the large crystals of spodumene the larges uncovered being over 42 feet in length and 4½ feet in section. Many of the crystals were over 30 feet in length. It has been estimated that over 50,000 tons of spodumene have been produced from the Etta pegmatite. The Tin Mt. Deposit 10 miles west of Custer is a similar type of deposit from the standpoint of the occurrence of large crystals. The Tinton deposit produced over 8500 tons of flotation concentrate during the war period and has considerable reserves in place at this time.

Amblygonite, a lithium aluminum phosphate, has been produced from a number of pegmatites in the Black Hills including the Ingersoll, Hugo, and Tin Mountain deposits. No facilities are available in the U. S. for processing this mineral and all shipments have been shipped to Germany.

Lepidolite the third lithium mineral of importance, a lithium mica,, has only been shipped from the Ingersoll mine at Keystone. It was in great demand during the war for special glasses used in the war effort and as a result of this stimulus , following a great deal of research work by the Black Hills Keystone Corp a flotation plant was built during the war to process some of the lower grade reserves and as a result some 8700 tons of lepidolite were shipped to two glass companies, during that period. This plant was probably the only one of its kind in the world and produced the only lepidolite flotation concentrates.

As a result of all of the activity in the production of lithium minerals the U.S. reached a peak production of 13,319 tons in 1944. Due to high freight rates it has been impossible for the Black Hills to compete with North Carolina production following the war years effort.

Beryl

The mineral beryl became of stretegic interest during the second world war as a source of the metal beryllium which was used as a moderator in the mechanics of setting off an atomic explosion. By slowing down the speed of neutrons entering the uranium neucleus an unstable condition developed in the Uranium atom resulting in its disentegration of the uranium atom and thus releasing the great energy stored up in the atom. Heavy water was the other material being used for this purpose. Hence an intense effort on the part of the U. S. government to develop reserves of the mineral beryl or other beryllium minerals resulted in a concerted effort to develop increased tonnages from the Back Hills. The price of beryl rose to $600.00 per ton for 10% ore and proportionately higher for higher grade ore.

The main source of beryl, in the United States, for many years had been the Black Hills. The mineral is a complex silicate of aluminum and beryllium containing betwen 4 and 5 per cent beryllium. The mineral usually occurs in small crystals in the mica zone of pegmatite dikes, associated with soda feldspar, quartz, tourmaline and mica, the larger masses occurring associated with segregated bodies of potash feldspar and quartz and lithium minerals.

The first economic interest in beryl from the Black Hills dates back to 1930- a ton of beryl crystals was mined and shipped from the Sitting Bull mine at Keystone, owned by the Back Hills Keystone Corp, to the Brush Beryllium Corp in Cleveland. At the time a great deal of experimental work was under way to develop procedures to produce the metal on a plant scale. One of the major difficulties encountered was the tendency of the element to crystallize to such an extent that specimens looked like honeycombs. Even to this date work is under way to modify the the crystalizing property of the metal so that it can be used in structural members for air and space flight. The metal when properly formed has the tensile strength of steel and is only slightly heavier than magnesium thus cutting weight loads of planes and missiles. It also has the physical property of absorbing heat rapidly and disipating it as rapidly, the term being applied to this physical property is the "heat sink" and is used in the rentry vehicle bringing the astronaut back to earth. It also has the property when used as an alloy material to the extent of about one per cent of the total to make copper as hard as steel when properly heat treated, allowing the copper alloy to be molded into any shape while still maleable and heat treated afterwards. Hence as the brief review just give will indicate beryllium has some very important uses. Its oxide, formed into discs, act as electrical valves and resist high temperatures , hence being used in electronic equipment in space vehicles. It, however, has some very difficult problems of processing due to the poisonous nature of beryllium oxide resulting from its processing procedures. Workers in the plant, in the early stages of the process development, incurred a disease called berylliosis , which at times did not show up for a decade and represented a delayed form of a lung desease.

In completing a contract with the War Production Board during the second world war the Black Hills Keystone Corp at its Ingersoll mine at Keystone encountered probably the largest Beryl Crystals ever uncovered. In the Pahasapa Quarterly of the South Dakota School of Mines , December 1919 appeared an article titled: Largest Known Beryl Crystal". At the time it was recorded some 2½ feet of the crystal had been removedand from sections then exposed it was estimated that the crystal would have weighed 4800 pounds. Later mining operations revealed that the remaining length was only 31 inches thus giving the crystal a length of five feet in all. It was imbedded in quartz, feldspar and amblygonite. Later operations, in 1942, exposed other larger crystals in the same environment in the same dike. One particular crystal exposed was 19 feet in length - eighteen inches in section on one end and five feet on the other end. Dr. Hess of the Rare Mineral Division of the U. S. Bureau of Mines wanted to make a national monument out of it. He felt

that this would be about the largest crystal of beryl ever to be encountered and hence was worthy of being made into a national monument. However the economic value of the beryl at the time was a consideration and as a result the crystal was mined out and produced 34 tons of beryl. Other crystals in the same dike produced considerable tonnages. One nine foot eight inches by eight foot six inches, but only four foot six inches in length produced 26½ tons. Three others each produced 16 tons, 11 tons and6 tons each. The largest beryl crystal to be found in the mine was on what was termed Dike No1. This was uncovered in 1944, had length of 28 feet a width of 8 feet 4 inches in secion and produced a total of 61¼ tons. Previously in this same dike in 1943 a crystal 24 feet long but irregular in shape pfoduced 26 tons and a second crystal next to the largest one produced almost a similar amount 26½ to

A summary of the beryl production from this mine indicates that the property has produced 525 tons of beryl. Other large producing mines, but not having the spectacular crystals, have been the Beecher Mine at Custer which has produced an estimated 500 tons and the Peerless Mine an estimated total of 550 tons.

Tantalite-Columbite

Another mineral for which the Black Hills has been noted is the Mineral Tantalite, usually associated with columbite. Over a long period of time the Back Hills has been the only producing state in the union for this mineral. It was first noted in the placers at Tinton, later developed into a product from the Tantalum Hill mine, the material being shipped to England for processing. In 1936 the Fansteel Metallurgical Corp of North Chicago, Ill., after an exhaustive search thru out the United States for a source of the Mineral, leased the old tin mill of the Back Hills Tin Company, revamped the plant into a concentrating unit for tantalite and operated the Tantalum Hill property for the mineral. They also operated a placer on Mallory Gulch from which they produced some 22 tons of concentrate during the year which was shipped to North Chicago to separate the tin fraction by high intensity magnetic separators. Some 25 tons of concentrate were realized from the milling operations as well. It proved to Fansteel that a source of supply could be developed here or elsewhere from low grade deposits. Their only source of supply at the time was West Australia. The other producing mines in the Black Hills included the Beecher lode at Custer which produced a total of over 30 tons of the mineral; the Tin Mountain Mine at Custer and the Black Hills Keystone Corporation's Ingersoll mine at Keystone. Other smaller tonnages have come from many other properties but in small amounts. In the search for Tantalite mineral , microlite, at the Ingersoll mine a mass of pitchblende was uncovered. From this mass several samples were sent to Washington and from the nature of the alteration an age determination of the Black Hills was made indicating an age of 1.3 Billion years, which was later increased by further determinations.

WHERE'S THE COPPER?

History of the Discovery, Exploration and Development of Copper in the Black Hills

By A.I. Johnson, Mining Engineer.

Copper is one of the oldest known metals in the world, along with gold and silver. At the present time we hear almost nothing about copper occurring in the Black Hills but its presence was recognized at an early date by the Newton-Jenny Party in 1875.[1] Although the search for the metal was not of great interest or economic importance, many prospectors spent considerable time and effort looking for it.

Numerous mining claims were located on prospects indicating copper from north of Deadwood to south of Custer with the most activity in the Keystone-Rochford area. During the past year I have attempted to investigate these many prospects. I was assisted by Dr. Kenneth Leonard who lent interest and enthusiasm in the project. With his four-wheel drive vehicle we were able to get to many otherwise inaccessible places and, sometimes, we had to go many miles on foot. Dense underbrush, weathering and erosion have obliterated much evidence of workings.

Dr. Joseph Connolly and Dr. C.C.O'Harra of the South Dakota School of mines listed the most promising prospects.[2] First was the Newton-Jenny discovery near the former town of Sheridan, now the location of Sheridan Lake. It was filed on as the Blue Lode in 1879 for copper, gold and silver. Later it was known as the BLUE LEAD (Leed). It was patented with 23 claims in the group under Mineral Survey 1483 in 1901, located in Section 13, Township 1S, Range 5E, Black Hills Meridian, Pennington County, south of Sheridan Lake 5.5 miles and northwest of Keystone. The adjacent DAKOTA-CALUMET-CONTINENTAL group is to the south with 12 patented claims under MS 1497. The Black Hills Copper Smelting Company was the owner in 1895.[3] of the two combined groups.

The DAKOTA CALUMET was the most extensively developed. On the CALUMET there was an 850 foot shaft, 1170 feet of adit at a depth of 300 feet with nine drift tunnels. On the BLUE LEAD there was a 260 foot shaft and a 1610 foot tunnel. The 1000 foot vein surface exposure analyzed 2% copper, which was good, and some cobalt, mulybdenum and small amounts of gold and silver. 4/ and 5/

The deposit was worked intermittently from 1878 to 1919.[6] Copper ore was shipped to Deadwood and Omaha smelters in 1917-1918, totalling 643 tons.[6]

Some ore was treated in a matte furnace on the Calumet. An ore zone was opened near the top of a hill and, from the 850 foot shaft there, an aerial gravity tramway conveyed buckets of ore to the smelter. The smelter was equipped with two 80 horse power boilers, an 80 hp Bates Corliss engine, a Connellsville blower sufficient to supply air for two furnaces and an eight

drill Sullivan air compressor. The smelting was done in a 42 by 84 inch copper matting furnace. Ore bins provided storage for ore and fluxes and there were the usual buildings. A.C. Overpeck of Keystone was the superintendent. Most of the miners walked back and forth to work from Keystone.

Both properties are on a shear zone extending from over a mile north of Sheridan Lake Dam to an area south of Eagle Mountain near the Keystone Wye. On the southeast of Eagle Mountain, samples show metallic copper. A similar sample, taken by John Moodie in the early 1900's, was found at Hayward to the southeast which could have been carried by drainage by way of Tepee Creek in Foster Gulch into Battle Creek which flows to Hayward.

Identification of copper minerals included malachite, azurite, chalcopyrite, bornite, tetrahedrite, covellite, pyrrhotite associated with graphite, arsenopyrite, chrysocolla, cuprite, tenorite and metallic copper in this area.[5] Later studies by the U. S. Geological Survey added nickel and cobalt and considerable molybdenum and zinc.

Located east of the Dakota-Calumet in the vicinity of the Silver Mountain fault, the WEALTHY mine was filed on in 1879. In the following years a 20-stamp mill was under construction but never completed. In 1905 Omaha capitalists purchased the mine for $70,000 and later the group was sold to the Farrars, Vic Jepsen and John B. Henry, Rapid City businessmen, and capitalized for one million dollars. A 125 foot shaft was reported on the ore vein and an estimated 300 foot drift on the 125 foot level completed. The company was later organized as the Wealthy Copper Co.[9] We find no evidence of any tailings from milling operations so there seems to have been no actual production.

In the western part of the Black Hills the BLACK HILLS COPPER company's claims were on Copper Reef Mountain, also called Whitetail Peak, five miles southwest of Rochford. The company was incorporated in March 1899 and its holdings were composed of five patented claims: the Climax and the Bee, MS 1912, and the Solnar, Copper Reef #1 and #2, MS 1983. At one time the company held 27 claims, covering 510 acres but because of financial difficulties eventually lost all by 1919.

By 1902 an 800 foot shaft and a 100 foot crosscut to the shear zone were completed. The shear zone was exposed for a mile and is still visible. Two large cuts of about 150 feet with a width of 20 feet were developed south of the shaft and these were the source of the ore that was shipped. Twenty carloads of high grade ore were shipped to the D &D Smelter at Deadwood and to Omaha before 1902. Another shipment to Omaha was made in 1917 from old surface workings and dumps.[8] The property has been idle since 1919 when the incorporation expired and now there is no evidence of any recent operation.

The EBNER-SOHOLT mining claims were on the same mineralized zone as the

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Black Hills Copper Co. holdings. Two claims are patented, the Gopher MS 19181, and the Gopher Mill site MS 3091B. The other six, the Graphite, East Bluick, Ten Dollar, Copper King and Copper King #1 are unpatented. Exploration consisted of several adits 20 to 80 feet long and an inclined 15 foot shaft, all caved in now. Ore of a relatively high copper content was limited to less than 100 tons.

The ore deposits occur in three separate and parallel shear zones, paralelling the schistocity.

The CUSTER PEAK COPPER COMPANY properties were in Secs.13,24,T3N,R3W, and Secs.18,19, T3N,R4E, in Lawrence County. The company was incorporated in Feb. 1901 under the original name of Custer Peak Mining and Milling Co. by John O'Brien of Nasby, John Wise of Hill City, I.N. Blackwilder of Chicago, William Wheatley and John Russell both of Deadwood.

Conditions similar to those at the Black Hills Copper Company prevail.[2/] Exploration consisted of a 250 foot shaft and 12 small surface pits. Two other shafts were reported. Again, there is no evidence of past or present operations.

The BLAND COPPER CO. holdings present quite a different type of deposit on French Creek, about 13 miles southeast of Custer, and now within Custer State Park. Close to intrusions of pegmatite, the copper mineralizations appear associated with lenticuler masses of quartz in schist. The minerals are bornite and tetrahedrite. The deposit has been explored by several cuts and shallow shafts.[2/]

Two mines in the area of the Bland are the COPPER QUEEN and the MAGGIE. The Maggie mine belonged to Ed N. Davis of Custer and Hermoan Reinbold of Omaha. It showed a vein from which analyses gave 24.5 % copper, 17% nickel, 3.5% cobalt, 10 oz. silver and $18.26 in gold, about one ounce. The vein was reported 14 feet wide of hornblende, schist and quartz, with very rich shoots. The group included 240 acres, well-watered and timbered.[3/]

Samuel Scott described the occurrence of malachite and metallic copper in sandstone, not far away, about six miles west of Fairburn.[9/]

Other properties reported showing evidence of copper mineralization had some development work done on them. Among them were the POISONED OX, the COPPER REEF and the COPPER GLANCE on Rapid Creek at Pactola, one-half mile from the former Sherman home; the RIO TINTO on the county line nearthe headwaters of Bogus Jim and Jim Creeks; theHOLY FRIGHT, farther north, one-half milesoutheast of Nemo on Box Elder Creek; COPPER CASTLE, three miles northwest of the Holy Fright. Occassional prospects extended from Deadwood southwestward to the Pennington County line, nearwhich are grouped the COPPER CLIFF, the BRITISH AMERICAN and the BLACK HILLS. These lie near the south fork of Rapid Creek, northwest and west of Rochford. The small mill there

The REYNOLDS property was southward two or three miles from that group. Still farther south was the PALMER property. The MASTIFF was west of Hill City a nd one mile south from the Uriah Gillette ranch buildings. Beyond this southward were the TRUAX and the VIGILANTE. Another claim, also named the HOLY FRIGHT, was situated on the east side of Tepee Creek in Foster Gulch and the east of Eagle Mountain, one mile up the creek from the George Palmer place, which is now the West River Childrens Home.

In the Northern Hills, the MONTEZUMA-WHIZZERS and SEIM properties are located in Secs 22,27,34 T5N, R3E in Lawrence County adjoining Deadwood on the southwest and west and adjacent to Homestake property. A group of 12 claims was patented under MS 1324 in 1899 by James T. Gillmore and Robert Giltner. The claims had been located between 1884 and 1894. The principal work was done on the Montezuma-Whizzers claims.("Montezuma" for the Aztec chief, but why the term "Whizzers"?)

A 650 foot tunnel contacted the iron dike from which raises and stopes were made. From these, chutes carried pyrite ore to mine cars which trammed the ore to railroad cars, thence to smelters in Deadwood or Rapid City.The ore was said to have averaged 39% sulphur, 39% iron, 1% copper and some gold. Many thousands of tons were shipped to smelters for fluxing purposes.[10/] On the iron dike some samples assayed as high as 40% copper.

In 1954 a Bureau of Mines crew found workings extending south from the Deadwood Creek portal for 650 feet with stopes up to ten feet wide. Later, a road project exposed the workings, the drift, ore cars and rusty mining equipment.[11/] In 1984 we found no evidence of recent work.

The SEIM mine consisted of 60 acres of patented ground also adjoining Deadwood on the south. A vein of pyritic ore suitable for flux at the smelters was worked for several years. Two tunnels, 560 and 530 feet long, showed a vein 80 feet wide.[10/]

Two types of gold ore were being produced in the area, the free-milling and the refractory. The refractory gold ore presented a difficult problem. To treat these ores the first matte smelting was introduced in 1890 by Dr. F.R. Carpenter, dean of the School of Mines. Two smelters were built. The Deadwood and Delaware, known as the D & D, and later the Golden Reward, was located in lower Deadwood and Dr. Carpenter took charge of it. The Horseshoe Mining Co., also known as the National Smelting Co., built their smelter in east Rapid City above the present School of Mines and opened in 1902. These smelters created an immediate need for copper ores carrying sulphides and the search for such ores was intensified.

The gold ore was fed into a large brick and iron furnace, with limestone a fusible mix, coke for heat and the sulphides were added. Forced air for a draft burned the coke and the mixture was melted. The sulphides, having an

affinity for the gold, collected it as well as any silver and copper present and, because of its heavier specific gravity, settled to the bottom of the furnace as the matte. The ash from the coke, the limestone and valueless parts of the ore formed a slag which was drawn offcthrough holes and conveyed to the dump. "The dumping of the molten white hot slag produced a grand spectacle, especially at night." [11/] The matte containing the gold, silver and copper was drawn into molds below the slag called "tap holes" and shipped to a refinery. The National Smelter was reported to have used a water cooling process on the slag to break it into small particles,instead of a molten mound, and these particles were used by the railroad for ballast along the tracks.

Later developments in metallurgy replaced the smelting process with chlorination and cyanidation plants. With the closing of the smelters, the interest in the copper sulphide deposits dwindled.

So----where's the copper?

Dr. O'Harra in 1902 stated"The deposits, insofar as surface conditions seem to indicate them, are numerous, extensive, and well-distributed, but as yet none has been steadily productive." and "The Black Hills copper deposits are frequently compared with the Ducktown, Tenn., deposits and apparently with much reason. The country rock is much the same in general character, the structure is not greatly different,the general dip of the veins approximately the same, the gossan or iron hat in each case is well-developed, the leached and decomposed slates are equally prominent, and the sulphides below contain more or less copper. Nickel is said to be present. The chief similarity yet to be established....is in the intermediate zone not yet penetrated in the Black Hills, and that zone, being the horizon where the valuable sulphide enrichments of the Ducktown deposits were found, perhaps holds the key to succesaful development of the Black Hills deposits. That such enrichments exist here is quite possible and indications are that they may oe found." [7/]

In the early 1970's Raymond, King and Norton, in the summary of their findings in the Blue Lead and Calumet area state "One can be optimistic about the existence of some kind of metal deposit. Mercury analyses yield results that imply sulphide mineralization in the area and anomalous amounts of other metals.....indicate that mineralization may have been of considerable magnitude. Molybdenum is perhaps the most promising.....but copper and silver, despite the lack of success of early exploration, are not beyond hope. The body of iron formation crossing Calumet Ridge has an average thickness of about 0.4 miles for a distance of 1.5 miles. Shafts and crosscuts having a total length of only about 4000 feet, with few surviving records of the results, seem inaufficient to explore a body of rock this size." [5/]

From my personal observation and in view of the extensive mineralization, I would concur with the thinki-

what depth we might find an economically profitable copper deposit is hard to predict but I would say "There's the Copper!" Maybe?

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THERE IS TUNGSTEN IN THE BLACK HILLS, TOO

BY A. I. JOHNSON, Mining Engineer

My interest in tungsten goes back to 1916-1917 when I was a senior in Lead high school, and interest was high in prospecting for the ore. Mr. Deve, head of the chemistry department, had set up a laboratory for making quantitative and qualitative analyses for tungaten and an assay furnace for gold as most samples contained both metals.

Tungsten is a heavy, silver-colored metal which occurs in several varieties of minerals. Wolframite is mainly iron tungstate, and black; hubnerite which is mostly manganese tungstate, and ferberite, an iron tungstate, are black; sheelite, calcium tungstate, is white to yellow. Wolframite occurs most prominently.

In certain types of ore deposits, tungsten minerals are of frequent occurrence and have a wide distribution, but in the aggregate, the amount of metal present is usually small. It occupies the paradoxical position of being somewhat rare but a metal of comparatively common occurrence.

The word wolfram came from the Anglo Saxon word for wolf, as the tungsten "stole" some of the tin from tin ore used in smelting "as the wolf eats up the lamb.". Tungsten is a Swedish word for "heavy stone" and it was formerly applied to what is now called sheelite, named for a famous Swedish chemist called Scheele.

There was a primary need for tungsten for armament production during World War I and later. Its chief use is in high speed tool steels and with non-ferrous alloys for drawn wire filaments. The unique properties which make it valuable are its high melting point, its tensile strength, its high specific gravity, it is para-magnetic and it can be drawn into small size wires.

Tungsten was identified in wolframite in the Southern Hills in 1883 and 1885 by Blake, a government geologist, when there was interest in tin development. Prof. Jenny may have discovered a tungsten mineral at the Comstock mine four miles south of Deadwood on the S.R. Smith property. Hubnerite is mentioned in Dana's report in 1893 at the Comstock. Headden, a chemist, gives an analysis of hubnerite in 1906. In 1899, Prof. Ritz of the Lead high school analyzed the so-called "black iron" in the gold ores and found it to be tungsten. This resulted in the shipment of 17 tons of the ore to eastern manufacturers, followed by smaller amounts until the war demand came in 1915.

Up until 1915 all production from the Black Hills came from hand-sorted ore. Then the Homestake Mining Co. set up a milling plant for tungsten ores, on Gold Run, a short distance below the Amicus mill, with a capacity of 20 tons of ore per 24 hours. A ten-stamp mill had two auxiliary ball mills. The concentrate was made on a Wilfley sand table and three Diester slime tables. The concentrates were dried in a steam dryer for shipment to market.

Another plant had been set up by Wasp #2 Mining Co. in the Yellow Creek

district south of Lead. This was an auxiliary to their cyanide unit and it treated hand-sorted materials from their several properties.
Other plants were set up. One in the Two-Bit district belonged to Pioneer Tungsten Co. Three plants in the Southern Black Hills at various times included that of Black Hills Tungsten Co., 5 miles east of H ill City; one belonging to Elkhorn Tungsten Co., south of the Black Hills Tungsten, and one by the Hill City Producers Co., using the old Hill City Tin mill.

There were five major occurrences in the Northern Black Hills. 1. The Harrison mine area east of the Homestake Open Cut at Lead. 2.Yellow Creek operations of the Wasp #2, the Bismarck Mining Co. north of the Wasp #2, and the Etta property north of the Bismarck. 3. In the Two-Bit area the Pioneer Tungsten Co. was involved on the S. R. Smith property and the Mary Group was on upper Two-Bit Creek. 4.The Denis Henault Claims on Lower West Strawberry Creek 2 miles south of Pluma. 5. Claims on the north edge of Deadwood, a short distance east of a road leading to the Roosevelt Monument.

The tungsten ores in the Northern Hills are related to the porphory intrusives of tertiary age. Most of the mineralized areas are related to fractures developed by the intrusion of porphories. The residual solutions from the intrusive replaced calcareous sediments in the Cambrian formation. Evidence from later explorations indicate there is a granite intrusive of the pre-Cambrian era in the area.

In the Tinton area placers, scheelite was found in nodules , indicating a replacement of limestone. No particular deposit has been identified nor has wolframite been found except in small amounts in dikes worked for tin.

Dr. Kenneth Leonard and I have recently visited all the areas in the Black Hills where tungsten has been noted.

As aforementioned, the Harrison Mine area, owned by the Hidden Fortune Gold Mining Co., was formed about 1900 by consolidation of gold-tungsten claims, including the Harrison, Sula, Durango, Grant Reddy, Golden Crown, St. Patrick and the Iowa, Brunsett, Swamp Eagle, Spokane and Bingham mines. Homestake purchased the property in 1912 and operated for tungsten from 1915 to 1919 and from 1927 to 1929. The Durango and Harrison produced some tungsten.

In the Yellow Creek area the Wasp #2 Gold Mining Co. produced tungsten as a gold by-product. In 1915 18 tons of concentrate brought $267, 443. In 1918 tungsten was milled at the nearby Bismarck or Alder Creek plant. Ore from the Etta claim on the divide between Whitewood and Yellow Creeks, north of the Bismarch, was owned by the Homestake and ore was similar to that of the Wasp #2.

The S. R. Smith Group, also known as the Comstock or Two-Bit, consists of Two Bit #1 and Two Bit #2 and Yellow Jacket claims on Two-Bit Creek, 5 miles south of Deadwood,and was taken over in 1941 by Pioneer Tungsten Mines. A 45

foot tunnel produced hubnerite (which Prof. Jenny had discovered in the late 1880's). In 1916 Sasse and Wolf leased the property and produced 1600 pounds of high-grade, hand-picked ore. The Mary, or Brosnahan, Group on Two-Bit Creek, consisting of the Mary, Union, Smith, Power and Power #2 patented claims were also taken over by Pioneer Tungsten and a 30-ton mill was built. In 1916 Martin Brosnahan shipped 1600 pounds of hand-sorted tungsten ore and also sold 300 pounds of high-grade specimen material. His son, John Brosnahan, panned and shipped 100 pounds of concentrates from the property in 1940.

The Denis Henault Claims on Lower West Strawberry Creek, located by him, are of interest geologically for the most part.

The claims on the north edge of the city of Deadwood showed evidence of tungsten but little development was done.

Between January 1915 and June 1918 the value of tungsten produced in the Northern Hills was over one million dollars.

In the Southern Black Hills many occurrences of tungsten are noted in the Harney Peak and Hill City areas with some showing at Spokane and Keystone, They are closely associated with the pegmatite phase of Harney Peak granite. The lithia-bearing pegmatites are not favorite hosts for the tungsten ores. In the quartz-rich parts, tungsten ores are more common. In the quartz veins which show a concentration of muscovite and graphite along the walls of the vein, a good source of tungsten is found.

Dr. C.C. O'Harra of the School of Mines has listed 29 claims whichhave produced or indicated possibilities of tungsten in the Hill City area.

One group located four and one half miles southeast of Hill City included the McKinnon and Miller Claim, Michigan Placer ground on Palmer Gulch, Vida May, the Blackbird Claim and the Martha Washington which had a quartz vein of high grade wolframite.Pettit and Pfander's Claim three miles southeast had scheelite also.The High Lode was on the east side of Summit Peak three miles southeast of Hill City. Rundle, Mills and Casler claims two miles southeast showed some black tungsten mineral. Indications of wolframite have been found at Downing's claim seven miles southwest of Hill City. The Tungsten Lode was six miles south of Hill City. The Edna Hazel, four and a half miles northeast of Hill City had wolframite crystals one half to two inches long in a vein of clear glassy quartz. The Hayes Claim 200 yards northeast of the depot had small dull crystals of wolframite. The Annie a half mile west of Hill City produced some wolframite in the quartz vein and there were good tin prospects. The Wolfram Lode on the south side of Slaughter House Gulch 600 feet southeast of the Annie had wolframite in small crystals in a quartz vein containing graphite, biotite and muscovite along the border. The Coats Claim one mile southwest of Hill City had small amounts of wolframite in pegmatite. The Mills Brothers' Prospect one mile south of Hill City on the east side of Spring Creek valley, 250 feet above the railroad, had

some wolframite exposed.

On the Reinbold Claim five miles south of Hill City on Sunday Gulch north of Sylvan Lake, tungsten ores are located mostly on the contact between small veins of pegmatite and schist. The tungsten mineral is hubnerite in slender crystals from one half to two inches long. One hundred tons of hubnerite were produced.

On the property of the Elkhorn Tungsten Co., also four and a half miles southeast of Hill City, are exposed at least five distinct veins of tungsten bearing quartz. The westernmost vein was worked out with specimens of good ore recovered. Four hundred feet east a quartz vein exhibits a rude banding lengthwise with mica, graphite and wolframite in plates. Seventy-five feet northwest of the second vein a third reaches a depth of 90 feet in a shaft with underground drifts and raises. Some ore was marketed of good quality. Another vein about 150 feet northeast of the power house was exposed in a 100 foot trench and contained quartz with muscovite and wolframite. Two hundred yards south of the power house a quartz vein exposed in prospect cuts and a small shaft showed small amounts of muscovite and wolframite. On this property were a power plant, hoist, and a small concentrating mill. Some ore was mined by the Black Hills Mining and Milling Co. in 1916.

On the Success Claim of the American Tungsten Co., four miles east of Hill City, wolframite occurred in a quartz vein in bladed aggregates up to two and a half inches long and was especially rich.

American Tungsten also had the Good Luck Claim in the same area and wolframite, ferberite and a little scheelite were found in a quartz vein cutting graphite mica schist. The vein was exposed in the main shaft to the 40 foot level, a drift for 97 feet and in a small shaft 47 feet southeast of the main shaft to the 40 foot level and also in a winze sunk from the 40 foot level near the main shaft for 30 feet. On the 40 foot level the vein was ore-bearing for at least 50 feet and in the winze to the bottom. The wolframite occurred in tabular masses, some attaining a weight of eight or ten pounds and single cleavage blades were found with a length of over eight inches. Some green scheelite was found in the quartz. About 40 tons of good ore were stoped out from above the 40 foot level. Several specimens of ore weighed from 50 to 100 pounds. There was a power plant, shaft house, hoist, mine tools and a concentrating mill.

The Cleveland Lode in that area also belonged to American Tungsten. Wolframite occurred in crystals up to two and a half inches long with muscovite in a glassy quartz vein.

The Champion Lode four and a half east of Hill City had wolframite in the

quartz and muscovite-rich parts of a coarse pegmatite which also contained feldspar and tourmaline. The dike was opened up by several cuts to a depth of 20 feet for a distance of 600 feet along the strike. Across the road from the south end of the lode a quartz vein one to two feet thick in pegmatite contained good crystals of wolframite. This vein was opened by a 15 foot prospect hole.

At Gireau's Claim four and a half miles northeast of Hill City a tungsten vein was exposed in a 30 foot shaft with wolframite in a quartz vein.

The Black Metal Claims, consisting of the Black Metal and the Black Metal Numbers 1,2,3,4,5,6,7, and 9, a mile north of Hill City, were extensively prospected by the Black Metal Mining Co. In January, 1911, a mineral patent was issued to the Wolf Tongue Mining Co. The group was sold in 1944 to Herman Huemme of Boston, Pa.,sold again in 1946 to Clyde and Blanche Kyes of Rapid City, and again in 1953 to Albert and Frances Carlbom of Hot Springs who sold to Allan and Celia Bradley, the present owners.

About 400 feet from the south end of the group, on Black Metal #3 is a quartz vein which cuts a gray, fine-grained quartzose mica schist where there was found some black shining wolframite in irregular masses as much as an inch in thickness and several inches in length. Farther south another vein showed wolframite extending into the quartz in blades up to one-eighth inch thick and two inches long which encouraged further prospecting. On the west side of China Gulch on the #5 claim some wolframite was found mixed with light-colored cassiterite in masses up to two pounds in weight. During the tin boom this ground was held as a tin claim. On #6, near the north end of the group, a four foot wide vertical shaft 65 feet deep, a vein carried wolframite intimately intergrown with light gray cassiterite in tabular masses one and a half inches thick and eight to ten inches broad. Where a narrow granitic dike lay along the vein in places, the vein was richest. Southwest of this vein on the same claim a quartz vein carried some wolframite and at some points bunches of wolframite occupied the whole width of the vein.

On the Black Metal #7 a thin quartz vein carried wolframite and small pieces of green and white scheelite. On #8 was an irregular quartz vein that carried some wolframite and small particles of scheelite of a delicate green color.

The Fern Clif mine belonged to Friend Robertson. It is one-half mile north of Spokane, seven miles east of Harney Peak. This occurrence is of special interest for two reasons: It lies in a region near the lithia-bearing pegmatites, where, with but two minor exceptions, tungsten is unknown and it is the only known occurrence in the Black Hills of primary scheelite in important quantities. Two quartz veins, the western and the eastern, both vertical,

seemed to apex at a point four feet thick. There the veins were exposed in a 30 foot shaft with a drift along the east vein for 30 feet and a smaller shaft was sunk 24 feet deep on the west vein. The scheelite and wolframite occurred intimately intergrown, and separately, in irregular masses, some three to four inches in diameter in a glassy quartz matrix. The greater part of the scheelite was primary, precipitated simultaneously with the wolframite. There seemed to be more scheelite than wolframite. In places the ore was very high grade. At different times, various groups operated the mine but no production figures seem to be available.

On the Reinbold Claim one-half mile northwest of Spokane tungsten minerals occurred in seams of quartz from one to eighteen inches wide, cutting a pegmatite. There were a 50 foot shaft and several prospect cuts.

The Etta Mine which belonged to the Standard Essence Co., later operated by Maywood Chemical Co. and now owned by Chord, is just south of Keystone. It yielded a small amount of wolframite and possible scheelite.

Negligible amounts of wolframite and scheelite were found in placers in the Harney Peak district.

In view of the many occurrences of tungsten in the Hill City area it seems possible that larger deposits may exist.

Bearing in mind that the specific gravity of wolframite is 7.2 to 7.5 and one cubic foot of the pure mineral weighs approximately 460 pounds, we can realize how concentrated the wealth in it becomes and how often a small seam in a mine might bring important returns.

In the whole United States, the Tungsten Mine of Union Carbide Co. at Bishop, California, known as "The Mine in the Sky", is unique worldwide and it is still in production of sheelite. In the past the tin mines of Cornwall had been significant producers. Boulder County, Colorado, was a principal producer of ferberite during World War I. At present the principal production comes from southeast China, the Malay Peninsula and Korea.

March 1988

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SILVER, PAST AND FUTURE

By A. I. Johnson, Mining Engineer

Silver has been the incentive for exploration of many parts of the world, including North and South America, Mexico, Norway, India and East Africa. The principal source of silver in the world has been Mexico. The Spanish discovered it at Taxco in the state of Guerrero and the king of Spain received his one-fifth share regularly. Mexico became a treasure house of silver.

At the World's Fair in Chicago the premium was taken by a 380 lb. piece of metallic silver from the Batopilas area in the Chihuahua district of Mexico. It had taken three stron mules, changing loads every ten miles, to carry it out forty miles from the mine. Approximately 80-90% of the silver mined there was in the form of native matal in crystals, wires, coils, ferns, herringbones, plates, balls and irregular masses. One mass contained 440 lbs. However, there were great barren lengths between the lodes.

Around the 1730's the Nuestra Senora del Pilar yielded 40,000 pesos weekly for many years. The owner laid a sidewalk of solid silver ingots leading from the bishop's house to the church. Up until 1920 an estimated 300 million ounces of silver was taken from the Batopilas district (about 900 cu. meters). Several billion ounces are estimated to have come from the various districts.[1]

In 1984 we visited the Santa Eulalia silver mine near Chihuahua city which was discovered in 1587 and is still in operation at a depth of 3000 feet. The Comstock Lode in Nevada operated to a depth of 3000 ft. where water was encountered and work ceased. The two mines have similar geology with the ore occurring in pipe-like fractures.

In the Black Hills, beginning in 1876, the early miners were prospecting for gold but also found silver with the gold. In some cases the silver predominated in the ore. The principal silver occurrences have been at Carbonate Camp, north of Deadwood; Galena, five miles south of Deadwood, Belle Eldridge, on Spruce Gulch south of Deadwood; Silver City in western Pennington County; and Spokane Lead and Silver Mine five miles southeast of Keystone.

During the past year my friend, Dr. Kenneth Leonard, and I have inspected all the known silver mines and prospects in the Black Hills and have checked and verified other published reports.

CARBONATE CAMP.

The Carbonate Camp district was discovered in 1876. Credit is given to James Redpath and son L.B. Redpath who came from Virginia in the gold rush

a nd moved to the back ridges. They were horticulturists and there they planted apple trees. They staked out a gold claim next to the apple trees and called it the Virginia or the West Virginia mine. Redpath was unlettered and signed his name with an "X".[2]

R.D. Porter located the Red Cloud silver mine in 1878, Josiah Craig located the Silver King in 1879 and the Iron Hill mine, the biggest of all, in 1880. The first big year was in the summer of 1881. At least nine mines were claimed that year. Frank Bryant located the Spanish R; the Adelphi was located by Charles Miller and A. Danielson for silver and gold; Sol Hoffman had the Jefferson mine (4th in production) during the boom years; the five Calkins brothers bought Craig's Iron Hill and located the Calkins in 1883. The Seabury-Calkins and Iron Hill combination outlasted any other mine in the district.[2]

Carbonate Camp boomed with a shifting population. There was a post office, and all the necessary businesses of the day. Excitement began to ebb in 1890. The Seabury-Calkins was still operating in 1896 and the town was almost empty by 1898. The Seabury-Calkins and Iron Hill mines were taken over by Richmond Hill Mining Co. in 1939 from Carbonate Consolidated Mining Co. which had acquired it in 1937.

The Seabury-Calkins main shaft was 240 ft. deep and had a 260 ft. stope on the 65 ft. level. Frank Bryant's Spanish R was rated third in production and was the first to make money. Bryant had already discovered gold in Spruce Gulch in 1875 and had gradually moved on toward Carbonate. He was a cousin of William Cullen Bryant. At 425 ft. in the Spanish R water problems ended progress to greater depth. This depth was probably within 125 ft. of the Cambrian formation where most of the production has been derived, except for the Homestake. From the Spanish R $50,000 in gold was produced but no figure has been found for the silver.[3]

Seth Bullock, a famous Black Hills character, is given credit for organizing the Iron Hill Mining Co. and being the push behind building the first silver smelter in the camp in 1885.He had a pyritic smelter in use in 1890 and the arsenic fumes from it were said to have killed all cats in town and caused sore throats and lung trouble. This Iron Hill mine had a 460 ft. shaft. In 1891 the price of silver dropped and the ore vein was lost. $736,000 worth of silver was produced in 1885-91. Some work was done in 1895. In the period 1901-11 dump tailings brought 18,511 oz. of silver plus gold and lead. A 300 ft.drainage tunnel was driven on the 300 ft. level of the Iron Hill.

It was reported that $5 million worth of silver bullion came out of

the camp. Many unsuccessful efforts were made to process the Carbonate ores, necessitating shipment to the D&D Smelter in Deadwood, or Omaha smelters, or even to Wales. The problems are unresolved to this date.

The Carbonate ore bodies occur in a fracture zone, the result of the intrusion of porphories into the limestone. Major ore bodies occur along this fracture throughout the depth of the development carried out. Ore bodies widen and thicken according to local conditions along the fracture. The Deadwood, or Cambrian, formation underlies the formations so far developed. The horizons that could be developed might provide the reserves of ore-bearing material similar to that hereto developed in the upper sections of the mines.[4]

Ewoldt states"the ore possibilities in the area are tremendous. There is a series of parallel fissures to the south of the main fissure of the Home Run and Buntz workings. Prospecting where these fissures intersect porphory dikes in the Pahasapa limestone should open new ore bodies. There is no reason that the Deadwood should be barren under such an extensive mineralization as is present in the Carbonate Camp District."

Samples taken by Ewoldt and Watkins to the School of Mines showed average silver 7.26 oz. per ton, gold .18 oz. per ton, lead 2.70%, manganese 7.38% and insolubles 26.80%.[5]

GALENA

The first discoveries of silver in the Galena area date back to 1877. For several years the principal developments were in placers in Bear Butte Creek. As a result of these operations, interest was created in the source of the placer values and various mines were located during the period 1881-84.

The geology gives a picture of the area. Professor Joseph Connolly stated,"The district has been a fairly important producer and many believe it will become so again, not only from presently known ore bodies, but from others which might be discovered by intelligent exploration in localities showing favorable geologic conditions."

The ore deposits are all in the Cambrian formation, the lower contact ores being situated in a quartzite bed a few feet above the Algonkian schists, and the upper contact ores lying some 300 ft. stratigraphically, within a few feet of the contact with the Whitewood limestone. The ore bodies are replacement deposits in dolomite quartzite on the lower contact and sandy dolomite on the upper. All ores have been extensively oxidized.[6]

The principal mines on the lower contact are: New Silver Queen, Cora, Horseshoe-Comet, Alice, Groshong, Hayes and Coletta. The principal mines on the upper contact are:Richmond-Sitting Bull, Merritt No. 1 and No.2,

Florence, Branch Mint and Red Cloud.

The New Silver Queen is typical of the lower contact deposits. The main fractures run northeast with variations. The ore occurs in flattened lenticular bodies conformable with the bedding, with thicknesses from an inch to two feet and diamter from a few inches to 15 or 18 feet. The ore material consists of lead and high values in silver. Pyrite is abundant and galena is rare.

The ores of the upper horizon are two to two and a half miles to the northeast, down Bear Butte Creek. The ore horizon is very sandy dolomite, approaching quartzite and dips to the east at an angle of 8-10°, the floor is quartzite and calcareous shale. Thickness varies on the north side of the creek from 18-30 ft. where the ore is mainly gold at the Gilt Edge, Rattlesnake Jack, Union Hill and Oro Fino.

The Richmond-Sitting Bull on the south side of the creek (later known as the Double Rainbow) is typical of the mines on the south side of Bear Butte Creek where the thickness of the ore runs from 24 in. to 14 ft. Here, cross fractures in connection with the main fracture appear to have influenced the general mineralization of the district.[7]

From 1881-83 over $750,000 in silver was produced but long litigation over apex rights for sixteen years and a drop in the price of silver brought action to an almost complete stop.

In 1938 the Barton Brothers of Pierre built a flotation plant which was not successful. The plant manager was James Harder and the superintendent was Harold Ewoldt. Several attempts to operate small properties were unprofitable, one was that of Colonel Davey.

The original production of silver was limited to only the highest grade because the cost of team and boat transportation to Omaha was so high. Lower grades were left in place.

One of the largest operators in the Galena district was the Branch Mint Mining Co. with over 200 claims, a 20-stamp mill and their own railroad from the mines to the mill.

In 1967-68 the Homestake Mining Co. in agreement with the U.S. Geological Survey and the Double Rainbow had an exploration project. Rich ore was found in pockets but not enough to merit extended mining.[8]

Galena may revive as a mining town or remain as a pleasant summer resort.

BELLE ELDRIDGE

The Belle Eldridge Co. produced a concentrate of lead, silver and zinc, the only producer of silver-lead ore in the Black Hills during World War II. Located one and a half miles south of Deadwood on the east branch of Spruce

Gulch, it originally operated with a 25-ton stamp mill. During the war the flow sheet was changed to a continuous ball mill and crusher operation.

Located in the Cambrian formation with geology similar to the Bald Mountain and Carbonate areas, the intrusions of porphory in the upper Cambrian show fracture zones carrying the silver-lead ores. In 1944-45 the company diamond drilled to the lower contact of the Cambrian and high-grade ore was encountered.

At the present time a drilling program is in progress.

SILVER CITY

Located about ten miles west of Mystic on Rapid Creek, Silver City was the locale of considerable mining activity in 1876 until 1935.

John Gorman and cousins Thomas and Luke from Buckingham, Quebec, were the first campers and called the site Camp Gorman. John and Tom started placer mining. They located the Diana Lode, a fissure vein in the Pre-Cambrian schist which carried gold and silver values, antimony and tin.

In 1885 Camp Gorman was changed to Nebraska Bar, a placer claim of six acres. A man who came from Silver City, New Mexico, did not like the name Nebraska Bar and said everyone thought it was a place to buy drinks He said since there was silver in the ore, the place should be named Silver City, a suitable name for such a beautiful place. The residents agreed.[9]

The Bureau of Mines lists the following silver producing mines in the Silver City district. The Diana group of seven daims had a 450 ft. tunnel which was the first exploration in this area. Duggan's Whim and Duggan's Shaft are west and southwest of Silver City. At the Grand View to the northwest there was a small stamp mill before 1905, yielding a small production of lead-silver concentrate averaging 4 oz. of silver. Frances Hoffman did sampling and development in 1939-40.

The Jenny Gulch property, northeast of Silver City, had a 600 ft. tunnel with shafts, drifts and crosscuts. The Midnight Prospect in Sunnyside Gulch is northwest of Silver City and east of the Grand View. The Huney Prospect two miles northwest of Silver City, known as the old Tom Gorman ground, had a 60 ft., two-compartment shaft, a 10-stamp mill which operated for a short time on ore from an open cut.

The Home Lode group of eight claims was the last to be operated in the district, about 1917.

There was a 60 ft. shaft on the Jenny Gulch property and a 205 ft. one on the Arsenopyrite Lode with levels at 100 and 200 ft. L.D. Richards, who had been manager of the old Grand View,furnished a 5-stamp mill and a Chilean mill for fine grinding which was moved to the Home Lode in 1916

from the Grand View. It was rebuilt as a 30-ton concentrating amalgam plant and 15 tons of silver concentrate were recovered in 1917. The Jenny Gulch Mining Co. unwatered and sampled the Home Lode in 1938 but only assessment work has been done since then.

SPOKANE MINE

The Spokane Mine, about five miles southeast of Keystone, was opened before 1898. In 1900 a group of men from Cleveland, Ohio, organized the Cuyahoga Mining Co. That Company had 29 contiguous claims, including the Spokane and Cuyahoga, covering 580 acres. The Cuyahogas were on Iron Creek about five and a half miles west of Spokane.[11]

During the period 1900-18 a 300 ft. shaft was sunk with a 500 ft. drift on the 200 ft. level and a 150-200 ft. drift at the bottom of the shaft. Twenty-four carloads of hand-picked galena and one car of concentrates were shipped. On this basis a mill was built.

About 1918 F. A. Gira became general manager for the Spokane Lead and Silver Co. The company introduced an ill-fated "new wrinkle" into local mining. A boring tool which had been used in digging a sewage system in Cleveland was shipped to Keystone. It was so large it had to be completely taken apart at the mine site and lowered down the shaft in pieces to the 300 level. Here it was re-assembled and used in one three to five minute round befor the bits were worn out. They tore it apart again, took it back to the surface and shipped it back to Ohio. Eastern investors sometimes had no idea of problems which had to be met in the hard rock mining field!

A flotation mill ran only a short time as insufficient ore was on hand to run. The Spokane ore is in a fissure vein from one inch thick at the surface to 14 feet wide on the 300 level. Analysis in 1927 by the School of Mines laboratory showed 4.94 oz. per ton.

In the early 30's a former mine foreman from Lead was in charge. The men were paid in groceries. At the end of the week they could draw groceries against their wages. There were no dollars to pay them. The Spokane site was a busy place when the mine and the mill were operational, with houses for workers, a schoolhouse, grocery store which was quite well-stocked, office building and others. Timber was cut on the site for the steam boilers to furnish power. Most of the workers didn't have enough money to get far from home.

SUMMARY

In this paper we have outlined the history of the discovery, exploration, development and production of the silver deposits of the Black Hills. The geology and development to date indicate the possibilities of large

reserves of silver ore. The proper exploitation of these prospects will depend upon the finding of a successful method of extraction of the ores.

Our research on the Silver Queen ore in 1940 using flotation methods indicated further study could be successful. In order to process the Belle Eldridge silver-lead concentrates satisfactorily we worked out a differential flotation procedure to remove the zinc which interfered with satisfactory smelting.

A flotation method used at Tinton to separate lithia minerals and at the Ingersoll mine at Keystone for low-grade lepidolite and in the early 60's to make a beryl product from pegmatite material were all successful. A possiblemethod of treating silver ores, based on separation by flotation, is indicated.

A further stimulus is the price of silver which has risen from $0.20 to $6.00 per ounce.

March 1986

FOOTNOTES

1. Silver. Mineralogical Record. Jan-Feb. 1986
2. Silver is the Fortune- Mildred Fielder
3. Ibid.
4. Harold Ewoldt & Vernon Watkins Report for Richmond Hill Mining Co. 1940.
5. Ibid.
6. Tertiary Mineralization of the Northern Black Hills- Joseph P Connolly.
7. Ibid.
8. Silver is the Fortune-Fielder
9. Silver City-Florence Burke
10. Ibid.
11. Rapid City Journal Interview with A.I. Johnson 3/30/74

THE GOLDEN SLIPPER STORY

By A. I. Johnson

Moses Manuel was the name of the man who is remembered as having discovered and located the Homestake claim which was to become famous in the history of gold in the Black Hills. Born in Quebec, Canada, Manuel as a young man began a life of adventure through Minnesota, Dakota Territory and into Montana and then followed the gold rush to Alaska. He met with some success there but, because of the cold and privation, he decided to return to Helena, Mont., where he met his brother Fred.

They learned that two of General Custer's soldiers, Horatio N. Ross and William T. McKay, had found placer gold in the Black Hills in the summer of 1874. Moses and Fred organized a party and headed for the Black Hills in 1875, arriving in the Custer City area where the gold had been reported but finding nothing exciting there or in the Hill City area. They were among the first to prospect Palmer Gulch near Harney Peak and eventually drifted to Deadwood and the big find was staked April 6, 1876.

However, their search in the Palmer Gulch area led to interest by other prospectors and on March 6, 1893, a promising claim was located by J.N. Wright, J.F. Wright, G. H. Wright, Sylvester Judd and James Bothwell about four miles east of Hill City, near Spring Creek at the mouth of Palmer Gulch. Following the custom of giving colorful names to the mines, they named this one the GOLDEN SLIPPER.

Several years previous to this there had been a tin boom in the vicinity of Hill City but, following cessation of the tin operations and a lag in placer gold mining, interest intensified in exploring for the source of the placer gold. Placer gold refers to free gold recovered from stream beds by panning, rocking or sluicing, using water to separate the heavier gold particles from the sand occurring with it.

Lode mining is different. The lode or vein of ore must be determined by prospecting a likely deposit, taking samples for assays, followed by surveys and maps to indicate the size and direction of the ore vein under the earth's surface. Shafts then are dug into the mountainside and drifts and tunnels are developed along various depths of the shaft. Here the miners dig and blast the ore loose so it can be hoisted to the surface where crushers, mills and furnaces process the ore into the final gold bars.

The Golden Slipper is a lode mine so capital and equipment were required to sink the initial shaft 60 ft. deep with a drift running 150 ft. from that level. In the next seven years $46,000 worth of gold bullion was recovered, indicating rich possibilities. This was when the price of gold was only

$20.67 per ounce. Today's price would be nearly twenty time that amount.

The property changed hands several times in the ensuing years.

In 1900 the Empire State Mining Co. sunk the shaft to the 462 ft. level. Disagreements arose among the owners and the mine was shut down but later the accumulated water was pumped out of the shaft and it was sunk to the 550 ft. level. Drifts were also developed along the various levels of the shaft.

A stope is a horizontal opening driven up from a drift to expose the length and width of a mineralized area. The ore is drawn from chutes located on the drift level. In this method work is always continued upward. The ore from the chutes goes into mine cars which are hoisted to the surface through the shaft.

Small pockets of ore were taken out in this manner as work progressed. $200,000 was estimated to have been produced by 1909. Ore was processed at the nearby JR Mill.

The Forest City mine, also located in 1893, adjoins the Golden Slipper on the south. A shaft was sunk with four levels at 35 ft., 65 ft., 100 ft., and 165 ft. Crosscuts were run into the ore veins on the two lower levels. On the 165 ft. level the vein was wider and stronger, showing that large quantities of ore might develop at more depth.

Surface equipment for the Forest City consisted of several good houses, barns, a 10-stamp mill, engines, dynamos and pumps. Equipment on the Golden Slipper in July 1911 consisted of a hoist building and engine, mill building, blacksmith shop, pumps, tank, air compressor and receiver, drills, boiler and engine, Wilfley table, a 5-stamp mill, a boarding house and stable.

World War I came along and gold mining operations ceased and there was no further activity at the Golden Slipper until late 1933 when Empire Gold Mines was incorporated for one million dollars by H. Alex Johnson of New York, A. I. Johnson of Keystone and J.F. Schrader of Rapid City. The Slipper property and adjoining claims, the Forest City, the Climax and Florida lodes, had been relocated by Charles Roland and Frank Brown and their interests were later obtained by Dean McSloy of Tempe, Ariz., who still owns the group. The financial assistance for the reopening came from I. M. Uppercue, a car dealer from New York. H. Alex Johnson was sometimes confused with Alex Johnson for whom then then new Alex Johnson Hotel in Rapid City was named. H. Alex also made his home in the hotel but the two were not related.

Geology and mineralization of the area was studied in detail by L. B. Wright, a Canadian mining engineer and geologist for Homestake Mining Co. and by A. I. Johnson.

According to their reports the host of the quartz is Precambrian which

has been intruded into much older Precambrian sediments including argillite, a lime-schist. The Forest City vein is a continuation of the Golden Slipper vein which has been faulted about 100 ft. to the south on the east side of the Climax vein. Evidence indicated that all the veins had been injected along a pre-existing network of fault planes. Later faulting dislocated the veins formed along the earlier fault systems. There were at least two periods of metallization.

The mineralization which has attracted attention is of the gold-bearing vein quartz type. Gold occurs mainly in the native state in the quartz. The Golden Slipper quartz shows a fine pattern of contraction fractures, many of which serve as minute channelways for gold and sulphides. It is more permeable than that in other veins which may account for its greater average richness.

Later developments showed that the veins varied in width from twelve inches to five feet over a length of several hundred feet.

There seemed to be nothing about the ore that would provide any metallurgical problems in its treatment.

Wright made the following recommendations for further development of the mine:

1. Installation of headframe and hoist with 1500 ft. capacity at the Slipper shaft.
2. Retimber the shaft to water level and as much below as necessary.
3. Installation of steam sinking pump and unwatering shaft and mine workings.
4. Careful geological study and sampling of mine workings with a view to planning further development in detail.
5. Sinking 100 ft. of winze from a point to be chosen so as to best intersect the downward extension of the main ore shoot below the 350 ft. level, sorting and shipping such ores as may be encountered. (Winze: a shaft sunk from a drift or tunnel underground.)
6. Drifting from the bottom of the winze along vein and back under the main shaft, followed by a raise to shaft bottom and further development of shaft for depth.
7. Simultaneous further sinking of winze and shaft.
8. Continuation of north drift on 350 ft. level.
9. Drive shaft across to "replacement area".
10. Drive such other crosscuts and drifts as may be warranted by further geological study.

At this time A. I. Johnson was in charge of developing the property.

In October of 1935 Mr. Wright made another report stating that his previous recommendations had been pretty much carried out or were still underway and the results undoubtedly would justify continuation with the following additional recommendations:

a. Continue the 550 ft. level southward along the vein to a point beneath and beyond the Forest City workings.

b. At the point of intersection of the Climax vein with the Slipper vein (where the Slipper vein folds to the southwest into the Climax), which should be reached approximately 470 ft. south of the shaft, a crosscut should be driven along the Climax vein in either direction. This should reach, eventually, into the ground of the "replacement area".

c. If the results on the approximately 1200 ft. of drifting on the 550 ft. level continue to show encouragement, drive the 365 ft. level southward along the vein to its junction with the Climax vein.

d. Connect the 550 ft. and the 365 ft. with a vertical 3-compartment raise, which should then be carried to the surface.

e. Prepare and break ore until sufficient tonnage has proved that its treatment will cover cost of the mill with required improvements.

f. Lateral diamond drilling carried on from station at the end of the 550 ft. level south.

g. A raise to connect with the Forest City workings, mainly for ventilation and exit purposes.

Assaying should be done each day.

In April 1936 Wright made a progress report on important points resulting from the above program:

A. The encountering of four distinct ore shoots which are not too widely separated by intervening low grade material to enable the possible mining of the entire length on the 550 ft. level.

B. The vein zone appears to be as strong on this level as above, indicating excellent chances for continuation of ore with depth.

C. The location in Shoot #4 of a very rich concentration of gold the import of which is not large in the size of values of this particular concentration, but in that other concentrations can be expected with stoping throughout the plane of the vein in the mineralized areas. .. I am of the opinion that this level lacks about 100 ft. of reaching the critical area which I designated in October.

This and other developments should further enhance the ore positi
It is my opinion that a trial atope should be cut including #2,3 &
4 ore shoots. Assays taken by the R.M.C.and checked quite closely
company samplings indicate in analysis that an average grade of a
proximately $12.00 per ton can be realized by taking the vein as
comes through this section for a length of 160 ft.ascribing a valu
of only $1 per ton for the stretches of vein matter between defin
ore shoots. Further recommendations:

1. Extend the 420 ft. level 100 ft. southward along the vein, dumping the rock into the stopes below this level with divisions for ore and water.
2. Extend the 550 ft. level at least 100 ft. along the vein southward toward the Forest City workings.
3. Drive a raise in the #4 ore shoot to connect with the 420 ft.level following upward and to the south beneath the fault which limits the shoot at the north end. Any high grade material encountered to be carefully shot down on canvas and sorted rather than being shot into the muck pile.

"My view of the entire situation is that the work accomplished to date has been 100% within the possible ore zone and ---- following completion of the above recommendations and regardless of their outcome the shaft should be sunk to an additional vertical depth of 125 ft. and the sixth level driven.... You have a very promising gold property in which a number of veins are known to contain gold in commercial range, with some of the ore shoots known to be extremely rich. The property is well equipped for continued moderate scale development and can be brought to a continuous producing stage after the recommended development program."

By this time a 100 ton mill had been erected and milling operations continued on the ore that had been developed to the 550 ft. level. Towar the end of 1937 most of the ore available had been milled.

It appeared that the ore body had faulted. Neither Mr. Wright nor A. Johnson were available for consultation so another Canadian geologist was engaged to work out the geology. He suggested driving a drift to the eas This cost over $30,000 and no ore was developed. After this setback, Dr. F. C. Lincoln of the School of Mines was hired as a consultant and he in turn engaged A. I. Johnson to do field work. This work indicated to them that the ore body had faulted to the west and they recommended driving a drift 25 feet to the west. And Mr. Upjohn, who was then in charge, ord ed that this be done.

Mr. Johnson remembers being awakened after midnight one night at his Keystone home by an ecstatic Mr. Uppercue who shouted that the ore body had been reached as predicted. This area was developed and named the Lincoln Stope. It was developed to the surface and over $100,000 was produced in 1938.

Empire Gold Mines continued operating until late 1939. Bald Mountain Mining Co. leased the mine in Jan. 1940 and sank a 250 ft. winze on the 750 ft. level to the 1000 ft. level. The Homestake Mine was engaged to do drilling on that level. This work ceased in November 1941 due to complications caused by World War II.

With the increase in the price of gold, interest is again being shown in reopening this most interesting and promising gold mine, the Golden Slipper.

March 1, 1982.

HISTORY OF KEYSTONE MINING.

by A. I. Johnson, Consulting Mining Engineer

The first mining activity in the Keystone area resulted from the gold fever that brought the prospector to the Black Hills in 1876. The Harney Hydraulic Mining Co.opened the Mitchell Bar in 1881, bringing water by flume from Grizzly Creek to its placer operation. The first ten stamp mill was built to operate on ore from the Cross mine about two miles north of Keystone. A small community by the name of Harney, located one and one half miles east of Keystone, became an important placer mining camp but because of the depth of the gravel, operations became impractical. At Hayward about five miles below Harney placer mining reportedly employed over 300 men. Because of the extensive work in the area Hayward was designated the county seat of Custer County after a heated race in April 1877. Custer did become the county seat after it was discovered that Hayward is in Pennington County.

On the first of May. 1893, the first plat of the town of Keystone was filed, established from the Reed Placer by the Keystone Townsite Co. On the 13th of April, 1895,the Harney Hydraulic Mining Co. dedicated to the public certain streets and alleys of the first subdivision to Keystone, the Harney Addition. Later on, May 3,1899, the second addition was made to the town, designated as the Swanzey Addition. The Holman Addition on the east side was next and the Rocky Gulch Addition to the northeast is the most recent, dated in 1941.

During the early placer mining activity in the Keystone area, mica mining in the Custer vicinity stimulated interest in the development of the deposits in this region. The Peerless mining group was producing mica as early as 1881. Early reports of mica in this mine go back as far as 1879. Contemporaneously with the mica activity came the Tin Boom of the 1880's which resulted in the expenditure of over $10,000,000 of English capital in the Keystone and Hill City region. A town named Etta, now a part of the present town of Keystone, had a 100 ton tin milling plant in operation in 1885. As a result of this development the first public school was established, taught by Mrs. Olive McDonald. Another tin mill was built at Glendale, a mile and a half south of Harney. As a result of all the various activities in the present vicinity of Keystone, the community continued to grow.

From placer gold mining there came interest in the exploration for the source of the placer gold. As a result the Keystone mine was discovered in 1892 by Franklin and located by him and Reed. From the mine the town received its name. Miners from Pennsylvania, known as the Keystone State, are said to have named the mine, an appropriate name as Keystone is the key area of many minerals. The Keystone mine was also thought to be the Key to the source of the

placer gold on Battle Creek.

It is reported that Mt. Aetna, located just south of the Keystone mine, was named by Italian miners because its sha pe reminded them of the mountain in Sicily. On top of Mt. Aetna is located one of two location monuments from w hich surveys are calculated. The other monument is atop the "Key Stone", a large rock located near where the old Etta post office was established.

The Holy Terror mine had been discovered by William R. Franklin and his daughter on March 13, 1892.* Mr. Franklin reportedly named it after his wife, due to her continual chiding that he had never named a mine after her. The richness of the ore stimulated rapid development. During that year a discover shaft had been sunk at the discovery point to a depth of 50 feet. A one-half interest was given to Fayel and Amsbury in consideration of their construction of a five stamp mill. The mill was completed by March of 1895 and a report in the Engineering and Mining Journal of March 16 stated that a weekly clean-up of gold netted $8000 from five days run on ore from the shaft. The Rapid City Journal told of weekly gold outputs of $10,000 from the five stamp mill. By the end of the year the shaft reported at a depth of 502.6 feet.A December report showed 24,915 tons of ore milled during 1896 and 1897 with receipts of $180,266. Gold was only $18 per ounce at that time.

On December 25, 1898, arrangements were made to purchase the Keystone mine and it and the Holy Terror were connected on the 500 foot level by a cross-cut which was completed September 17, 1898. Shaft sinking continued and on September 9, 1900, had reached a depth of 1006 feet. Production for the two years had continued to climb, totaling $570,70 from 50,018 tons of ore milled. The Holy Terror was coming into the hey day of its life.

On October 22, 1901, while sinking the first 100 feet of the winze from the 1000 foot level, three men were killed by gases forced through air lines, the result of a hot compressor cylinder. As a result of this accident the property was fainally compelled to close down July 25, 1903, the company being unable to pay the heavy damage judgments imposed. During the period from 1901 to July 1903 the winze was driven down an additional 100 feet to a depth of 1200 feet and levels were developed to make possible the mining of the ore. At the time the mine closed down ore was being mined from both winze levels. An item in the Engineering and Mining Journal indicated that on November 1, 1902, the 20 stamp mill was being supplied with ore from these two levels.A study of the records of the Holy Terror Mining Company shows that during the period of its operation from 1894 to July 1903 it had produced $1,224, 755.77 in gold.

The town had grown to a population of over 3000 people. In 1902 two newspapers,"The Miner" edited by W.R. Reinard and the "Recorder" edited by

*The actual date was 1894, not 1892.

Charles S. Dillon, were being printed. There were three church buildings, the Methodist, Congregational and Baptist. A large school building had been completed sufficient to accommodate the growing needs of the community. The town had a 26 room hotel and was served by a growing bank.

However, after the forced closing of the Holy Terror-Keystone mine, the community began losing population. The mine had been the largest source of income for many families who were compelled to seek elsewhere for a livelihood. Three fires pretty well decimated the town; one on May 21, 1908, destroyed the east side of the main street, a second one on January 15, 1917, destroyed a considerable portion of the west side, another in 1921 burned most of the remaining business places.

An attempt was made in 1906 to unwater the mine and get it back into production. It was unwatered to the 500 foot level and the shaft re-timbered but due to many difficulties the attempt failed. It was not until 1938 that further operations were attempted by the new Holy Terror Mining Company.

During the interim several operations were undertaken in the Keystone district. The Bismark mine was developed between 1904 and 1907; a 30 stamp mill was erected but, according to reports, a lack of water and the inability to make a good recovery of the gold values caused a cessation of the work. Later, further attempts were made to open up the mine after the rise of the gold price from $20.67 to $35.00 per ouce. This work in 1936 was brought to an end due to lack of financing. The Bismark mine is north of the Holy Terror-Keystone properties.

In 1909 the Columbia mine across the highway from the Keystone to the south was opened up to a depth of 147 feet and later a second shaft to the 200 foot level was driven to develop the rich gold vein. From 1909 to 1917 this work continued intermittently. Some $33,000 in gold was recovered. Later the operation was consolidated in 1927 with the Keystone Consolidated Mines, operating the Bullion mine. They built a 100 to cyanide plant in 1928 and this was destroyed by fire in 1930 in January. Previously, in 1923, operations had been initiated to open up the Bullion mine. This company renovated what was known as the Blue Bird mill, converted it to a flotation plant producing gold arsenical concentrates. The company produced 97,185 pounds of white arsenic and extracted gold concentrates valued at $11,764.16. The price of white arsenic, which was being used to kill the cotton boll weevil, dropped radically from 14 cents per pound and the Keystone Arsenic Company closed down, but followed with further development of their ore reserves and consolidation with the Columbia gold mine. The mill they built under the name of Keystone Consolidated Mines, Inc. burned down in 1930.

In 1923 development was begun of the feldspar deposits in the Keystone area and the Keystone Feldspar and Chemical Company was organized. This company shipped crude feldspar to points in Ohio. The Consolidated Feldspar Corporation built a grinding plant in Keystone and produced feldspar from the Hugo and Peerless mines, continuing until January 1957 when their plant was burned down. During the years of operation feldspar production totaled some 350,000 tons. In 1933 the Black Hills Keystone Corp. started operations at the Ingersoll mine to produce beryl and during its operation produced some 9000 tons of the mineral lepidolite, used to make unbreakable glass. Beryl production from both the Peerless mine and the Ingersoll stimulated the economy of the region as this area was the largest producer of beryl, the source of beryllium, in the United States.

The Ingersoll mine had been located and developed in 1881 as a tin prospect by the Harney Peak Tin Mining, Milling and Manufacturing Co. Lepidolite was encountered at a depth of 125 feet in a tunnel driven to exploit the tin possibilities. At that time no importance was attached to the mineral until the active development in 1937 when a fairly large deposit was indicated. At first arrangements were made with the Consolidated Feldspar Corp. to graind the lepidolite to minus 50 mesh as required by the glass trade. A large quantity of low grade material and the waste from hand sorting was aegragated and experiments began to determine a feasible method to beneficiate the ore. A new plant was completed in June 1942 and ran on a 24-hour basis until September 1944 and produced 3956 tons of concentrates. There was also provision for crushing and milling mica-bearing pegmatite in this mill.

Production of spodumene from the Etta mine totaled over 50,000 tons and brought the Keystone region into focus as a producer of rare minerals. The Etta was unique for the variety of spodumene crystals encountered, some as large as four feet in section and up to 40 feet long. This mineral was in great demand for the war effort.

The gold operations of the Holy Terror mine continued through 1942 until closed down by government order in order to stimulate manpower transfers to strategic mineral and metal industries. This affected more than 65 employees. The company had undertaken unwatering the mine in 1939 a nd completed this work to the 500 foot level. A cyanide plant was constructed and milling started July 13, 1940, and continued until the government order of September 10, 1942. During those two years 60,796 tons of ore were milled to produce $272,796.48 in gold. Most of the ore came from the 500 foot level. Unwatering to the 700 foot level was continued and a drift was driven to connect the Holy Terror workings with the Keystone on that level.

Again Keystone had a sustained economy.

Southern Mines, Inc., purchased the Juniper mine in 1949 from Mrs. Jack Snowie. It had been located in early days by a Mr. Phinney and later acquired by Mr. Snowie. A shaft was sunk to the 200 foot level. A 75 ton mill was built with a combination cyanidaztion flotation process. It operated but a short time due to the loss of all its employees to the nearby new air base where higher wages were paid. Several years later the Holy Terror spodumene plant at Keystone was leased to Souther Mines. Water softening equipment was installed to produce a satisfactory product and spodumene was shipped to the Lithium Corporation plant in Minneapolis until that company transferred its Hill City and Minneapolis plants to Kings Mountain, N.C.

We should not neglect to point out the effect on the Keystone economy of the work on the Mount Rushmore Memorial. Work had been initiated on August 10, 1927, at the time of its dedication by President Calvin Coolidge and continued with many interruptions through the following years, when almost a million dollars was spent on the project. The figure of Washington was dedicated July 4, 1930. On August 30, 1936, President Franklin D. Roosevelt dedicated the figure of Jefferson and in the following year on September 17 the figure of Lincoln was dedicated. About two years later dedication of the final figure, that of Theodore Roosevelt, was held on July 2, 1939. After the death of Gutzon Borglum in March of 1941, his son Lincoln continued the work until funds were exha usted later that year in October. Borglum had envisioned an entablature depicting the highlights of American history, carved out of the stone behind the figures in an underground room. This part was never completed. Over 450,000 tons of granite were removed in outlining the figures as they now stand. Most of the men employed during the carving had been experienced as miners in the Keystone area although this was a far different type of work.

Another facet of the economy of the Keystohe area concerns the tourist facilities necessary to provide for the comfort and interest of those visiting the memorial and the Black Hills. The first tourist cabin camp was started in the early thirties. Since then all facilities have multiplied and visitors are counted in the millions each year.

With the stimulus of World War 11 needs, pegmatite operations for rare minerals grew rapidly. The Black Hills pegmatites were the chief sources of several [illegible] of the rare minerals in high demand. The Ingersoll and the Peerlesa mine became the largest sources of beryl in the United States. The beryllium metal was used as a moderator in the atomic bomb. The price of beryl reached a peak of over $600 per ton. The Peerless produced 685 tons and the Ingersoll 550 tons. The largest beryl crystal ever recorded was uncovered at the Ingersoll. It was over 19feet in length and another crystal was over

eight feet in section.

The Etta mine, of interest in the early days of the activity in Keystone, was a center of interest during the second world war for its production of spodumene. The mine had been the largest producer over the years and in former years crystals of pure spodumene over 40 feet in length and four feet thick had made this deposit famous to the geologist. Milling methods for lower grade deposits were developed and mills in both Keystone and Hill City were built to get further production. A heavy media plant was erected at the Ediso mine south of Keystone which eliminated hand sorting methods previously in use

The Holy Terror gold mill was remodeled to treat the spodumene tailings from the Etta mine dump. Recoveries were low so that operation soon closed.

Tantalite, another mineral in great demand during the war, was being produced from several of the mines in the Keystone vicinity.

During the sixties a new company, Northwest Beryllium, with Peggy Keenan as president, came into Keystone to develop by flotation methods the extraction of many minerals found in nearby deposits. Recovered in the mill at the Holy Terror site, were feldspar, mica, beryl and the accessory minerals cassiterite and tantalite. This operation continued from 1960 through 1968. At the height of its activity this company was employing 65 men.

Facilities for purifying q uartz, using the same equipment followed, as Pacer Corporation took over the mill site. Refined quartz and some tantalite were produced. At present there is limited production of the quartz.

Although mining activity at present is very quiet, the potential for production from the known reserves of the minerals mentioned is still very great.

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